Vol. I

TRANSCRIPT OF RECORD

(Pages 1 to 500)

Supreme Court of the United States

OCTOBER TERM, 1944

No. 50

THE DOW CHEMICAL COMPANY, PETITIONER,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY

No. 61

HALLIBURTON OIL WELL CEMENTING COMPANY, PETITIONER,

vs.

THE DOW CHEMICAL COMPANY

ON WRITS OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SIXTH CIRCUIT

PETITIONS FOR CERTIORARI FILED {APRIL 6, 1944.
APRIL 17, 1944.

CERTIORARI GRANTED MAY 15, 1944.

Supreme Court of the United States

OCTOBER TERM, 1944

No. 50

THE DOW CHEMICAL COMPANY, a Corporation,
Petitioner,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY,
a Corporation,
Respondent.

TRANSCRIPT OF RECORD

On Petition for Writ of Certiorari to the United States Circuit Court of Appeals for the Sixth Circuit

Volume I—Pages 1 to 500

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IN THE

UNITED STATES CIRCUIT COURT OF APPEALS

FOR THE SIXTH CIRCUIT

No.....

THE DOW CHEMICAL COMPANY, A CORPORATION,
Plaintiff-Appellant,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY,
A CORPORATION,
Defendant-Appellee.

Appeal from the United States District Court for the Eastern District of Michigan, Northern Division

---

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2	Grebe patent 1,916,122	15	1504
3	Grebe-Stoesser patent 1,998,756	15	1509
4	Chamberlain patent 2,024,718	15	1512
7	Bureau of Mines Bulletin 148	29	Vol. I, 29
9	Chart of patent applications involving use of acid in wells, filed from 1866 to 1939	63	1515
9½	Revision of Exhibit 9	80	1516
10	Chart entitled "Streams of Knowledge"	65	1517
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	Dunn 1,067,868	50	1541
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14	Item in Midland paper regarding new Dow well treating process, dated June 9, 1932	148	1626

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54	Ditto, dated 7/24/34.....	254	1642
57	Ditto, dated 8/15/34.....	254	1643
59	Ditto, dated 9/16/34.....	254	1644
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143	Item in Oil City Derrick for October 28, 1895, reporting acid treatment of wells by Frasch and Van Dyke.....	1194A	1656
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145	Ditto, for January 15, 1896.....	1194A	1658
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154	Bartell Table showing results of corrosion tests with defendant's truck (treating) acids on strap iron test pieces	329	1705
155	Ditto, showing results on test pieces of oil well pipe from National Supply Co.	333	1706
156	Ditto, showing results on test pieces of oil well pipe from Oil Well Supply Co.	333	1707
157	Ditto, showing results on test pieces of oil well pipe from Atha Supply Co..	334	1708
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159	Ditto, showing results on test pieces of oil well pipe from National Supply Co.	345	1710

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189	Prutton graph showing results of tests of 15% c. p. hydrochloric acid with different added amounts of copper, lead and iron	605	1754
192	History of oil development in limestone fields prior to 1932 and history of acidizing in those fields beginning in 1932, prepared by the witness Fitzgerald	178	1755–70
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196	Bulletin of Montana Oil Conservation Board	189	Vol. I, 187
199	Letter, Dow Co. to Oil Makers, 9-23-32	1171	Vol. III, 1172
200	Letter, Grasselli to Oil Makers, 10-14-32.	1174	Vol. III, 1174
201	Letter, Grasselli to Oil Makers, 11-1-32.	1175	Vol. III, 1175
202	Letter, Grasselli to Oil Makers, 1-26-33.	1176	Vol. III, 1178
203	Letter, Grasselli to Oil Makers, 9-15-32.	1179	Vol. III, 1179
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205	Oil Makers checks to Penn. Salt Co.	1196	Vol. III, 1196
216	Letter, Lee to Oil Makers, 2-7-33	1243	Vol. III, 1242
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233	Summary of well treatments made by licensees of Dow other than Dowell	845	1788

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234	Sketch and data prepared by Dr. Prutton showing rates of attack on oil well tubing of 15% c. p. hydrochloric acid and of 15% synthetic defendant's treating acid	840	1789
242	Dowell advertisement in Petroleum World, September, 1938	846	1790
243	Ditto for January, 1939	847	1791
245	Dowell, Inc., Service Price Schedule 110.	852	1792
246	Record of shipments of hydrochloric acid and arsenic inhibitor by Dow Company for period January to June, 1932, inclusive	121	1793
305	Affidavit of Robert Quinlan on the first treatment of a Pure Oil Company well with inhibited hydrochloric acid	1028	1794
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331	Data showing average time acid was in tubing in making the 122 treatments itemized in Exhibit 330	197	1799
337	Chart showing combinations possible under claims of Gravell Patent 1,678,775.	1320	1800
343	Alquist Table showing rate of corrosion of mild steel in various concentrations of hydrochloric acid	1365	1801
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344	Alquist Table showing acceleration of the rate of corrosion of hydrochloric acid containing an acid regulator caused by the addition of tin, cobalt or nickel	1370	1804
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355	Photograph of one-half gallon container used in Alquist's tests, and table and graphs showing results of tests.	1376	1827–29
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357	Table, graphs and drawing of equipment used by Alquist in making tests showing loss of strength of 15% hydrochloric acid when in contact with iron for different periods up to 24 hours.	1398	1841–46
358	Bartell Table showing summary of corrosion tests of various commercial hydrochloric acids of 15.1% strength..	499	1847
360	Table showing Dowell advertising 1932 to 1940, inclusive	1408	1848
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364	Poffenberger's report on tests of inhibiting value of arsenic compounds in hydrochloric acid	1423	1855
366	Carr and Humphrey patent application for method for increasing fluid production from oil wells	1427	1857–64

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367	Carr and Humphrey patent application on chemical reagent for use in oil wells	1428	1864–68
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369	Agreement between The Dow Chemical Company and The Pure Oil Company dated January 31, 1933	1428	1873–77
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8	Excerpts from article by R. Van A. Mills, dated December, 1923, entitled "The Paraffin Problem in Oil Wells".	35	1883
72	Letter from M. G. Harper to J. W. Van Dyke, dated December 5, 1895	1033	1884
73	Telegram, Harmon to Van Dyke, dated January 24, 1896	1033	1885
74	Memo from C. F. Lufkin to Van Dyke, undated	1033	1886
83	Telegram, J. C. Donnell to Van Dyke, dated November 25, 1895		1887
86	Telegram, Harper to Van Dyke, dated December 6, 1895		1887
88	Letter, The Grasselli Chemical Company to Van Dyke, dated July 26, 1895		1888
90	Letter, Herman (Frasch) to Van Dyke, dated September 22, 1895		1889
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102	Letter, Harper to Van Dyke, dated December 16, 1895	1047	1891
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105	Memo re Crossley Well No. 3 of Ohio Oil Company	1047	1894

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DEFENDANT'S EXHIBITS

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108	Letter, Harper to Van Dyke, dated February 5, 1896	1047	1895
109	Correspondence between Lufkin, Van Dyke and Donnell re acid treatments (July, 1895, and February, 1896)	1047	1896
110	Letter, Lufkin to Van Dyke, dated July 29, 1895		1900
111	Letter, Harper to Van Dyke, dated December 2, 1895	1047	1902
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113	Letter, Van Dyke to Grasselli Chemical Co., dated November 20, 1895		1904
114	Memo dated November 21, 1895		1905
115	Letter, Frasch to Van Dyke, undated		1905
132	Letter, Grasselli Chemical Co. to Van Dyke, dated July 19, 1895		1906
138	Letter, Lufkin to Van Dyke, dated August 2, 1895		1907
151	Report on scale formation in wells by Blaine B. Wescott	1081	1908–21
152	Report by F. W. Karl, dated February 1, 1929, re treatment of William Berryhill Well No. 8	1087	1922
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191	Gardner Affidavit	750	Vol. II, 752
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223	Letter, Prutton to Rebbeck, 2-19-41	774	Vol. II, 775
224	Letter, Rebbeck to Prutton, 7-10-41	791	Vol. II, 791
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280	Hathorn's chart re tests on hard steel tank No. 1	854	1924
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286	Hathorn's chart re tests on soft steel tank No. 4	854	1930

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DEFENDANT'S EXHIBITS

Exhibit Number		Pages Identified	Pages Printed
287	Index for Hathorn's corrosion experiments	855	1931
288	Photograph of Hathorn's hard steel tank No. 1	855	1932
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294	Prior art patents	912	1935–88
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	Laverty 856,644	913	1939
	Beneker 914,916	915	1941
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	Holmes 1,470,225	916	1945
	Gravell 1,678,775	95, 897	1947
	Gravell and Douty 1,678,776		1950
	Fischer et al. 1,736,282	917	1954
	Rhodes 1,746,677	918	1957
	Rhodes 1,746,678	920	1961
	Vignos 1,750,651	920	1964
	Harrison 1,766,902	921	1968
	Corson et al. 1,773,953	921	1971
	Lawrence 1,780,594	922	1974
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	Calcott 1,785,513	923	1978
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	Corson 1,809,621	923	1985
	Carr 1,891,667	76	1988
300	Memorandum given by Grebe to defendant's witness Thomas	1012	1993
301	Letter, C. Plummer to The Dow Chemical Company, dated December 1, 1932	1016	1994–97
302	Memorandum of conversation with Ross T. Sanford, dated December 8, 1932.	1016	1998–99
303	Memorandum of conversation with John J. Grebe, dated December 8, 1932.	1023	2000–02
304	Preliminary draft of patent application of John J. Grebe, dated June 7, 1932.	1025	2002–09
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314	Conception data sheet signed by John J. Grebe July 2, 1932		2047

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IN THE

United States District Court

EASTERN DISTRICT OF MICHIGAN

NORTHERN DIVISION

Pleadings and proceedings before the Honorable Arthur J. Tuttle, Judge of the United States District Court for the Eastern District of Michigan, in the following entitled cause:

No. 45

THE DOW CHEMICAL COMPANY, A CORPORATION,
Plaintiff.

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY,
A CORPORATION,
Defendant.

COMPLAINT

(Filed June 15, 1939)

(1) This is an action for infringement of United States Letters Patent.

(2) Jurisdiction is founded on the Patent Laws of the United States.

(3) Plaintiff is a corporation created and existing under the laws of the State of Michigan, and has a principal place of business at Midland, Michigan.

(4) Defendant is a corporation created and existing under the laws of the State of Delaware, having a principal place of business at Duncan, Okla., licensed to do business in the State of Michigan, and having a regular and established place of business at Mt. Pleasant, Isabella County, Michigan, within the Eastern District of Michigan, Northern Division, where, and elsewhere, it has committed the acts herein complained of.

(5) Letters Patent of the United States were duly and regularly issued to plaintiff as follows:

No. 1,877,504, on September 13, 1932, for "Treatment of Deep Wells," as assignee of John J. Grebe and Ross T. Sanford, both of Midland, Michigan.

(Here are listed three other patents that are not involved in the appeal, viz., Grebe 1,916,122, for Method of Treating Wells with Acid; Grebe and Stoesser 1,998,756, for Treatment of Deep Wells, and Chamberlain 2,024,718, for Treatment of Wells.)

Proffert of said Letters Patent, or duly certified copies thereof, is hereby made.

(6) Since the dates of issuance of said Letters Patent plaintiff has been and still is the owner thereof.

(7) Letters Patent No. 1,877,504, aforesaid, were held valid and infringed by the United States Circuit Court of Appeals for the Tenth Circuit, in the case of The Dow Chemical Company vs. Williams Brothers Well Treating Corporation. (81 Fed. 2d 495.)

(8) Defendant for some time past, and within six years prior to the filing of this suit, has been and still is infringing said Letters Patent, and each of them, by practicing, in the Eastern District, Northern Division, of Michigan and elsewhere within the United States, the process of treating wells disclosed and claimed in said Letters Patent, and each of them, and particularly in Claims Nos. 1, 5, 7, 8 and 9 of Letters Patent No. 1,877,504; and will continue to do so unless enjoined by this court.

(9) Defendant has been notified of plaintiff's ownership of said Letters Patent, and each of them, and of its infringements thereof, and notwithstanding said notice defendant has continued said infringements.

Wherefore, plaintiff demands a preliminary and a final injunction against further infringement by defendant and those controlled by defendant, an accounting of profits and damages, and an assessment of costs against defendant.

AMENDED ANSWER OF DEFENDANT

(Filed Sept. 11, 1940)

Defendant, Halliburton Oil Well Cementing Company, answering the Complaint, filed on or about June 15, 1939, of the Dow Chemical Company, Plaintiff, says:

1. Answering Paragraph 1 of the Complaint, defendant admits that this is an action for infringement of Letters Patent.

2. Answering Paragraph 2 of the Complaint, defendant admits the jurisdiction of this Honorable Court.

3. Answering Paragraph 3 of the Complaint, defendant admits that plaintiff is a corporation created and existing under the laws of the State of Michigan and has a principal place of business at Midland, Michigan.

4. Answering Paragraph 4 of the Complaint, defendant admits that defendant is a corporation created and existing under the laws of the State of Delaware; that it has a principal place of business at Duncan, Oklahoma; and that it is licensed to do business in the State of Michigan and has a regular and established place of business at Mt. Pleasant, Isabella County, Michigan, within the Eastern District, Northern Division. Defendant denies that it has committed the acts complained of in the Complaint.

5. Answering Paragraph 5 of the Complaint, defendant admits that on September 13, 1932, United States Letters Patent No. 1,877,504 were issued to plaintiff, as assignee of John J. Grebe and Ross T. Sanford, for "Treatment of Deep Wells" but denies that said Letters Patent were duly and regularly issued.

* * * * *

6. Answering Paragraph 6 of the Complaint, defendant admits that since the dates of issuance of the several patents in suit the plaintiff has been, and was at the date of the filing of this action, the owner of said patents.

7. Answering Paragraph 7 of the Complaint, defendant admits that Letters Patent No. 1,877,504 aforesaid,

were involved in litigation in the case of The Dow Chemical Company vs. Williams Brothers Well Treating Corporation in the United States Circuit Court of Appeals for the Tenth Circuit (81 F. (2d) 495), but asserts that there is no connection whatever between the defendant in that case and the defendant herein and asserts that defendant herein is not using the agents for inhibiting corrosion claimed to have been used by the Williams Brothers Well Treating Corporation, or any of the agents for inhibiting corrosion referred to and defined in the claims of Letters Patent 1,877,504, in suit. Defendant denies that all the claims of Letters Patent 1,877,504 aforesaid, were held valid by the United States Circuit Court of Appeals for the Tenth Circuit and asserts, particularly, that Claim 9 of said Letters Patent 1,877,504, one of the claims charged to be infringed herein, was not before the United States Circuit Court of Appeals for the Tenth Circuit in the case of The Dow Chemical Company vs. Williams Brothers Well Treating Corporation, supra.

8. Answering Paragraph 8 of the Complaint, defendant denies that it has at any time infringed, and denies that it is now infringing, the aforesaid Letters Patent, or either of them, by practicing in the Eastern District, Northern Division of Michigan, or elsewhere in the United States, processes embodying the alleged patented inventions, and particularly claims 1, 5, 7, 8 and 9 of Letters Patent 1,877,504, and defendant denies that it will infringe any of said Letters Patent unless enjoined by this court.

9. Answering Paragraph 9 of the Complaint, defendant denies that it has been notified of plaintiff's ownership of said Letters Patent, or any of them, and denies that it has been notified of the alleged infringement of any of said Letters Patent and defendant denies that, notwithstanding notice, it has committed any acts of infringement.

Further answering the Complaint:

10. Defendant avers that plaintiff has asserted, and is asserting in this action, a broad and dominating monopoly wholly unsupported by any invention made by the alleged

inventors of the Letters Patent in suit, and wholly unsupported by any invention disclosed by the patents in suit.

11. Defendant avers that it is not using any invention claimed, or even disclosed, by any of the Letters Patent in suit. On the contrary, defendant is utilizing methods developed or designed by others than the patentees in the patents in suit. Defendant is utilizing, among others, methods described and covered by the following Letters Patent of the United States issued to defendant as assignee:

No. 2,122,483, Paul L. Menaul, July 5, 1938, "Methods and Means for Acidizing Wells";

No. 2,149,617, Paul L. Menaul, March 7, 1939, "Methods and Apparatus for Handling Acidic Solutions."

12. Defendant avers upon information and belief that the Letters Patent in suit, and particularly the claims thereof herein charged to be infringed, and each of them were so restricted and limited in scope by the procedure in the Patent Office prior to the issuance of said Letters Patent that such claims, and each of them, if valid at all, are not entitled to a construction which will include or cover any device, composition of matter or process made, sold, used or practiced by defendant; wherefore, defendant denies infringement of any of the claims of said Letters Patent.

13. Defendant avers upon information and belief that the claims of the Letters Patent in suit herein charged to be infringed cover mere aggregations or old combinations of method steps and not new patentable methods and are, therefore, invalid under the law.

14. Defendant alleges upon information and belief that the claims of the Letters Patent in suit herein charged to be infringed distinguish over the prior art existing at the time of the alleged inventions only by the substitution of known equivalent steps in the methods of the prior art.

15. Defendant alleges upon information and belief that the patentees of Letters Patent 1,877,504 in suit surreptitiously and unjustly obtained the patent for things which are in fact the invention of W. A. Thomas of Sagi-

naw, Michigan, now of Mt. Pleasant, Michigan, who was using reasonable diligence in adapting and perfecting the same.

16. Defendant avers upon information and belief that the claims of Letters Patent 1,877,504, charged to be infringed by this defendant, are invalid and void and of no effect for the following reasons:

(a) That the methods described and claimed in each of said claims, respectively, or material and substantial parts thereof, were patented or described in printed publications prior to the alleged invention or discovery thereof by the patentees of the patent in suit, or more than two years prior to their application for Letters Patent therefor, as follows:

United States Letters Patent

Number	Patentee	Date of Issue
288,150	B. F. Aiken, Jr.	Nov. 6, 1883
372,154	A. Krause	Oct. 25, 1887
556,651	J. W. Van Dyke	March 17, 1896
556,669	Herman Frasch	March 17, 1896
670,577	G. L. Ball	March 26, 1901
856,644	C. E. Laverty	June 11, 1907
914,916	J. C. Beneker	March 9, 1909
1,194,542	N. H. Raymond	Aug. 15, 1916
1,221,735	A. F. Hoffman, et al	April 3, 1917
1,325,293	L. S. Hoon	Dec. 16, 1919
1,365,141	M. A. Adam	Jan. 11, 1921
1,382,337	G. C. Bellis	June 21, 1921
1,398,507	J. H. Gravell	Nov. 29, 1921
1,399,651	Adolph Pessi	Dec. 6, 1921
1,410,827	W. F. Muehl	March 28, 1922
1,421,706	R. Van A. Mills	July 4, 1922
1,428,085	J. H. Gravell	Sept. 5, 1922
1,433,579	Otto Vogel	Oct. 31, 1922
1,460,395	Otto Vogel	July 3, 1923
1,470,225	Harry N. Holmes	Oct. 9, 1923
1,476,747	F. H. Wolever	Dec. 11, 1923

Number	Patentee	Date of Issue
1,498,045	F. W. Lake	June 17, 1924
1,513,371	A. C. Campbell	Oct. 28, 1924
1,524,435	A. F. Hoffman, et al	Jan. 27, 1925
1,531,173	J. D. Brady	March 24, 1925
1,549,411	J. H. Gravell	Aug. 11, 1925
1,608,709	R. Van A. Mills	Nov. 30, 1926
1,608,869	Elvin Tilton	Nov. 30, 1926
1,615,121	M. E. Fyleman	Jan. 18, 1927
1,619,835	B. S. Summers	March 8, 1927
1,632,833	J. H. Gravell	June 21, 1927
1,635,500	H. E. Potts	July 12, 1927
1,678,775	J. H. Gravell	July 31, 1928
1,678,776	J. H. Gravell	July 31, 1928
1,713,653	J. H. Gravell	May 21, 1929
1,719,167	G. D. Chamberlain	July 2, 1929
1,719,650	G. D. Chamberlain	July 2, 1929
1,721,389	J. H. Gravell	July 16, 1929
1,723,923	J. G. Davidson	Aug. 6, 1929
1,729,097	I. H. Derby	Sept. 24, 1929
1,734,990	A. H. Ackerman	Nov. 12, 1929
1,736,282	Chas. Fischer, Jr.	Nov. 19, 1929
1,746,677	Fred H. Rhodes	Feb. 11, 1930
1,746,678	Fred H. Rhodes	Feb. 11, 1930
1,748,494	Paul I. Murrill	Feb. 25, 1930
1,750,651	James C. Vignos	March 18, 1930
1,756,311	W. L. Semon	April 29, 1930
1,757,829	Viktor Bertleff	May 6, 1930
1,766,902	M. M. Harrison	June 24, 1930
1,773,953	H. P. Corson, et al	Aug. 26, 1930
1,780,594	R. E. Lawrence	Nov. 4, 1930
1,780,595	R. E. Lawrence	Nov. 4, 1930
1,785,513	W. S. Calcott, et al	Dec. 16, 1930
1,789,805	F. D. Burke	Jan. 20, 1931
1,796,839	J. H. Gravell, et al	March 17, 1931
1,804,078	M. W. Baden	May 5, 1931
1,805,052	L. B. Sebrell	May 12, 1931
1,806,499	Leo Ranney, et al	May 19, 1931

Number	Patentee	Date of Issue
1,808,185	D. H. Tomkins	June 2, 1931
1,808,188	D. H. Tomkins	June 2, 1931
1,808,200	T. W. Bartram, et al	June 2, 1931
1,809,621	H. P. Corson	June 9, 1931
1,822,271	G. W. Coggeshall	Sept. 8, 1931
1,823,439	Melvin DeGroote	Sept. 15, 1931
1,823,440	Melvin DeGroote	Sept. 15, 1931
1,829,705	J. C. Walker	Oct. 27, 1931
1,843,376	Richard Stusser	Feb. 2, 1932
1,843,783	August Regal	Feb. 2, 1932
1,850,757	S. I. Levy	March 22, 1932
1,861,176	Melvin DeGroote	May 31, 1932
1,861,177	Melvin DeGroote	May 31, 1932
1,873,083	J. C. Walker	Aug. 23, 1932
1,873,084	J. C. Walker	Aug. 23, 1932
1,881,721	J. M. Leaper	Oct. 11, 1932
1,891,667	R. H. Carr	Dec. 20, 1932
1,892,205	Melvin DeGroote	Dec. 27, 1932
1,894,759	Melvin DeGroote	Jan. 17, 1933

BRITISH LETTERS PATENT

163,519	Martin E. Fyleman	May 26, 1921

PRINTED PUBLICATIONS

Bulletin 233 of U. S. Bureau of Mines (1925)entitled "Protection Against Corrosion in Oil & Gas Fields";

Industrial and Engineering Chemistry, June 1928, Vol. 20, No. 6 pp. 582-587, article entitled "The Electrochemical Action of Inhibitors in the Acid Solution of Steel and Iron";

Petroleum Development & Technology (1926) "Corrosion in an Oil Refinery" by H. F. Perkins, Port Arthur, Texas, pp. 560-570 and discussion 479-480.

Corrosion—Causes and Prevention—1926, by Frank N. Sheller;

Chemical and Metallurgical Engineering, Vol. 36, No. 9, September, 1929, pp. 539, et seq. "Inhibitors as a Means of Reducing Corrosion" by E. L. Chappell.

Bulletin of Bureau of Mines entitled "Water Problems in the Northern Part of the Cushing Field, Creek County, Oklahoma" by D. P. Wardell, et al., February, 1927;

Chemical and Metallurgical Engineering, July, 1927, Vol. 34, No. 7, pp. 421-424, articles entitled "Practical Application of Inhibitors in Pickling Operations" by Speller & Chappell, and "Removing Rust from System with Piping Acid" by Speller, et al;

Principles of Electrochemistry by Blum and Hogaboom (First Edition) (pages 64-67);

Bureau of Mines Technical Paper No. 15, (1913), entitled "An Electrolytic Method of Preventing Corrosion of Iron and Steel" by J. K. Clement and L. V. Walker

and also other patents and printed publications, the names, numbers, dates and authors of which are not at present known to defendant, but which when ascertained defendant prays leave to add hereto.

(b) The methods described and claimed in each of the claims of Letters Patent 1,877,504 in suit do not involve invention over the prior art cited in paragraph (a) hereof, but represent, at most, the exercise of mere skill in the art.

(c) The patentees of Letters Patent 1,877,504, in suit, were not the original and first inventors or discoverers of the things patented thereby, or of any material or substantial part thereof, but prior to the alleged invention thereof by the said patentees of said Letters Patent, the same were, if invention be involved therein, invented by or known to the patentees listed in paragraph (a) hereof, at the addresses given in the Letters Patent and applications involved, and by:

Muskegon Oil Corporation, Muskegon, Michigan;

Gulf Oil Corporation, Pittsburgh, Pennsylvania, and its subsidiaries;

Grasselli Chemical Company, Cleveland, Ohio;

Ohio Oil Company, Cleveland, Ohio;

Solar Refining Company, Lima, Ohio; and
American Chemical Paint Company, Ambler, Pennsylvania,
Gulf Oil & Refining Company, Pittsburgh, Pennsylvania

and also by others not now known to defendant, but which when ascertained, defendant prays leave to add hereto.

(d) That prior to the alleged invention by the patentee in Letters Patent 1,877,504 in suit, or more than two years prior to the filing of the application for said Letters Patent, the alleged invention thereof had been in public use or on sale in the United States by:

Muskegon Oil Corporation, Muskegon, Michigan, at or near Muskegon, Michigan;
Gulf Oil Corporation, Pittsburgh, Pennsylvania and its subsidiaries, in or near Lee County, Kentucky; in or near Claiborne Parish, Louisiana; and in various places in Oklahoma;
Grasselli Chemical Company, Cleveland, Ohio, at East Chicago, or Grasselli, Indiana;
Ohio Oil Company, Cleveland, Ohio, at or near Lima, Ohio and Findlay, Ohio;
American Chemical Paint Company, Ambler, Pennsylvania, at Ambler, Pennsylvania;
Gulf Oil & Refining Company, Pittsburgh, Pennsylvania at Homer, Louisiana,

and by the patentees listed in paragraph (a) hereof, at the addresses given in their respective patents and applications therefor, and also by others not now known to defendant, but which when ascertained, defendant prays leave to add hereto.

(e) That Letters Patent 1,877,504 are invalid and void because granted by the Patent Office through inadvertence, accident or mistake. Defendant alleges that the Primary Examiner was interviewed during the pendency of the application which matured into Letters Patent 1,877,504, while the Assistant Examiner, who was an expert in the art, was away on his vacation. At this interview the Ex-

aminer was given to understand, intentionally or otherwise, that, contrary to the facts, the prior art did not disclose the use of hydrochloric acid for the treatment of oil wells. The Examiner informed counsel, in writing, of this understanding. Counsel did not correct the Examiner's mistaken views, but immediately paid the final fee and had the patent issued.

(f) That the invention or discovery purported to be covered by Letters Patent 1,877,504 alleged to have been the joint invention of John J. Grebe and Ross T. Sanford was in fact the sole invention of John J. Grebe only.

(g) That the invention or discovery purported to be covered by Letters Patent 1,877,504 alleged to have been the joint invention of John J. Grebe and Ross T. Sanford was in fact the sole invention of Ross T. Sanford only.

(h) That the invention or discovery purported to be covered by Letters Patent 1,877,504 alleged to have been the joint invention of John J. Grebe and Ross T. Sanford was in fact the joint invention of John J. Grebe, Ross T. Sanford and W. A. Thomas.

(i) That the invention or discovery purported to be covered by Letters Patent 1,877,504 alleged to have been the joint invention of John J. Grebe and Ross T. Sanford was in fact the joint invention of John J. Grebe and W. A. Thomas.

(j) That the invention or discovery purported to be covered by Letters Patent 1,877,504 alleged to have been the joint invention of John J. Grebe and Ross T. Sanford was in fact the joint invention of Ross T. Sanford and W. A. Thomas.

Wherefore defendant prays that said Letters Patent No. 1,877,504, be declared invalid and of no force or effect; that defendant be decreed to not infringe the aforesaid Letters Patent; that costs herein be taxed against the plaintiff; and that the Complaint herein be dismissed, and for such other and different relief as to the court may be just and equitable.

COUNTERCLAIM

The Answer included a Counterclaim based on Gravell Patent 1,678,775, issued July 31, 1928, for storage and transportation of acid mixtures in steel drums, which counterclaim was dismissed and no appeal taken therefrom.

STIPULATION RE PREVIOUS LITIGATION

The following stipulation was entered into with respect to previous litigation on Grebe and Sanford Patent No. 1,877,504:

"1. That suit was brought by the Dow Chemical Company vs. Williams Brothers Well Treating Corporation, on or about the 24th day of April, 1934, for the alleged infringement of United States Patent to Grebe et al., No. 1,877,504.

"2. That said suit came on for trial in the United States District Court for the Northern District of Oklahoma, before the Honorable Judge F. E. Kennamer, during the month of September, 1934.

"3. That by final decree on or about January 15, 1935, the Bill of Complaint was dismissed.

"4. Plaintiff, The Dow Chemical Company, thereupon took an appeal to the United States Circuit Court of Appeals for the Tenth Circuit, which appeal was docketed as No. 1285.

"5. That the decision of the Tenth Circuit Court of Appeals was as reported in 81 Fed. (2d) 495.

"6. That for the purposes of this stipulation, the transcript of testimony and the copies of exhibits printed in the transcript of record on appeal to said United States Circuit Court of Appeals, for the Tenth Circuit, entitled 'The Dow Chemical Company, Appellant, vs. Williams Brothers Well Treating Corporation, Appellee,' shall be considered as being true, complete and correct copies of such testimony and exhibits before the District Court, subject to correction of such copies of exhibits on comparison with originals thereof, should error appear.

"7. That if called and sworn to testify as witnesses herein, the following individuals,

L. C. Case	W. A. Hower
S. C. Kiser	R. S. Knappen
Harry F. Wright	R. L. Wright

who gave testimony in the aforesaid case of the Dow Chemical Company vs. Williams Brothers Well Treating Corporation, either on examination in open court or by deposition taken out of court, each would testify to the same facts as they testified to in the said former cause, subject to correction by any additional testimony of any of said individuals taken on behalf of either party hereto.

"8. That insofar as the same may be relevant to any issue herein, either party hereto may offer as evidence in this cause, any portion of the fact testimony of the above identified witnesses named in paragraph 7 hereof, or any portion or portions of any exhibit offered in the aforesaid Williams Brothers case, with the same force and effect as though such testimony had been taken or exhibits had been offered herein, subject to the right of the opposing party to object to any such offer on any ground that might be urged against it herein, if said witnesses had been sworn and examined, or such exhibit had been offered in this cause, whether or not such testimony or exhibit was objected to at the time it was taken or offered in said former cause."

NARRATIVE STATEMENT OF TESTIMONY AND PROCEEDINGS IN DISTRICT COURT

Following is a statement of the testimony and proceedings in the District Court, portions of which are in narrative form and other portions in question and answer form.

The following exhibits were marked and offered:

Copy of Grebe-Sanford Patent 1,877,504 as PX-1.

Copy of Grebe Patent 1,916,122 as PX-2.

Copy of Grebe-Stoesser Patent 1,998,756 as PX-3.

Copy of Chamberlain Patent 2,024,718 as PX-4.

Copy of Gravell Patent 1,678,775 as DX-5.

JAMES O. LEWIS,

a witness called by plaintiff, testified as follows:

DIRECT EXAMINATION

I live in Houston, Texas, and am a consulting petroleum engineer. I got my technical training at the University of Stanford where I graduated as a geologist, prepared for petroleum geology. After graduation I spent two years with the Associated Oil Company in California as a field geologist, and after that I spent three years employed by

Harry R. Johnson of Los Angeles and Robert B. Moran then of San Francisco. My work was partly field geology, concerned with oil, except for one special job of a few months, and also some engineering problems in the production and valuation of oil, and the drainage of oil underground.

I then went with the United States Bureau of Mines in the fall of 1914, and was with them for six years.

My first position was that of oil and gas inspector, doing joint investigation work for the United States Bureau of Mines, and the Indian agency of Muskogee, Oklahoma. I worked jointly with the Indian office and the United States Bureau of Mines investigating the causes and remedies for the waste of oil and gas which were then taking place in Oklahoma. I was in that work for one year, and I was then employed by the Bureau of Mines directly for two years in investigative work, mainly concerned with methods for increasing the recovery of oil; methods for estimating the future production of oil and gas, and other methods for conserving oil and gas. During that time I wrote three technical bulletins and papers for the Bureau of Mines.

In 1918 I was placed in charge of the Bureau of Mines Petroleum Experimental Station at Bartlesville, Oklahoma. The station was just being founded. It was the first petroleum station of the Bureau of Mines. Also during that year we had outside work—I mean in addition to the organization of the station, in helium problems, which were then active, working out methods for the Bureau of Internal Revenue, for estimating the reserves of oil and gas, to be used in connection with depletion allowance in income taxes, and other activities in Oklahoma, and elsewhere in the United States dealing with conservation.

During 1919 and 1920 I was chief petroleum technologist of the Bureau of Mines, that is, I was in charge of all petroleum work of the Bureau of Mines during those two years, and was located in Washington, D. C. I left the Bureau of Mines in 1920, and went to Marietta, Ohio, and became a member of the firm of Smith & Dunn. The firm

of Smith & Dunn had a patented process for increasing the recovery of oil by injecting air or gas into depleted oil fields.

In the fall of 1920 I moved to Tulsa, Oklahoma, with Mr. Dunn, and we formed the firm of Dunn & Lewis, which was in business together until about a year ago. Mr. Dunn was the inventor of this process of increasing the recovery of oil, also other processes for cleaning out wells, and helping recovery of oil and gas. Our business there was a general petroleum engineering business but specializing in methods for recovering oil and gas. We had a number of properties which we took over, some under management, some under ownership, to which we applied this process of Mr. Dunn's and other processes. We also had consulting work from larger companies, advising on various matters, namely, South Penn, Central, New Jersey, Tidewater, Petroleum Gas Company, and some other gas companies. During these years I have done a great deal of consulting work on valuation, estimations of oil and gas and various problems relating to the production and recovery of oil and gas. Mostly my work has been on the conditions which exist underground, and the methods for bettering the recovery of oil and gas therefrom.

About a year ago, I dissolved partnership with Mr. Dunn and have been located in Houston, Texas, as a consulting engineer in such problems. At present I am engaged in a joint problem for a group of companies in California, one of the largest fields there—the Kettleman North Dome Field—working out problems connected with what is known as the cycling of gas from the very deep sand which should be used by these joint operations. These companies include most of the larger operating companies in California. I also have similar problems on increasing the recovery of oil in some properties of an English company in Trinidad which company happens to be the largest producer of oil of any British-owned colony.

Q. Now, I wish you would tell the court, please, what were the actual conditions, we will say, before acidizing

became popular, as to the percentage of the oil in the ground which was actually gotten out. Tell them both as to limestone and sandstone. A. It has always been rather a difficult question to estimate how much oil actually is in the ground, and hard to give general answers in magnitude and figures. Also, there have been changes in the character of fields which have been found at different times and in the methods of producing that oil and gas. In the earlier part of the industry most of the oil was produced from what is known as tight sands—they call them sand but really they are sandstones, originally laid down as loose sands but in the course of geological changes have been cemented and the permeability had become quite low. The oil and gas found in them was quite difficult to obtain. While that character of field was being produced, the recovery was obviously quite low. In 1917 I estimated the average recovery was between 10% and 20%. That is, from 80% to 90% of the oil was being left underground. That was probably a little low. Probably they were getting a little more than that, as we since have found out. It wasn't very far from the real order of magnitude. Since that time the character of fields has been different. We have been finding more deep fields, more oil has come out from sands, more permeable, and have made advancements in recovery. So the efficiency of recovery is better, considerably. Probably at the present time the recovery is of the order around 40%.

Now, as to the limestones, there is much greater variability in the question of limestones, and consequently the percentage of extractable oil—probably on the average, the percentage of extractable oil is somewhat higher in limestones than it has been in sandstones. That is, instead of it being of the order 20% in the tight sands, so-called in limestone, it is more likely to be 30%, possibly a little greater. That was up prior to the extensive use of acid.

Q. Now, how long has it been since this increasing of the production of wells was recognized as a real problem to be met by the industry? A. Well, it was almost recog-

nized from the beginning to some extent. That is, the first producers found that the wells would come in in large volumes, comparatively large volumes, and then quickly the amount of oil which the well would produce would shrink, so they were almost immediately confronted with the fact of a diminished return following the completion of the well, and became interested in methods which would tend to increase the daily production.

They did not so quickly become conscious of the fact that after the well had ceased producing, they had not exhausted all the oil, but it was not many years before they commenced to see that they were not getting all the oil, though it took quite a long while for them to get a means of estimating quantitatively how much that was. They knew they were losing some of the oil, and it must be a considerable quantity. The original first Drake well, the first petroleum well in this country, was in 1859.

Q. And how long was it after that before they had some record evidence of efforts to increase the productivity of the wells? A. Well, from the standpoint of merely increasing the daily production of wells, with no respect to whether or not the ultimate production was increased, there are records almost immediately of going in and cleaning out wells. They recognized that the formations would cave off the walls of the hole and fill up the hole. They would go in and clean that out.

Also they had devices for lifting the oil by various pumping means. Gas lifts were first applied very early in the industry, at least, tried out, and as soon as a well ceased to flow under its natural pressure, there were many expediencies applied to increase its daily production.

Then, in 1865, the first method which went further than that, which went more than merely cleaning out the hole itself and bettering the lifting means, was applied by Colonel Roberts, who was the colonel in the U. S. Army during the Civil War who invented the torpedo, as he called it. That is, his method was to put in a charge of nitroglycerine into the well, explode it there, which would enlarge the hole and crack the formations back from the hole some distance, just

how far he did not know, and also tend to clean off the walls of the hole of obstructing materials.

Mr. Lyon:

Your Honor please, it seems to me that from the witness' last statement, something that happened in the Civil War, judging by the fact he said he was a graduate of Stamford University, and Stamford was not founded until the 90's, this witness is not testifying to anything of his own knowledge.

The Court:

I take it this is the recorded history, like who discovered the steamboat.

Mr. Lyon:

It seems to me this is not the proper way to prove it; to prove the history, I mean, by an oral witness.

The Court:

Well, if it is history, it cannot affect the decision of the lawsuit really. It is just background, and I don't want him to use up very much of my time or their money in order to prove this. I take it that if he isn't corrected by some of the people connected with your side he is correct about it. I take this as background and history of an art that goes way back beyond anything I will use in deciding the lawsuit, and yet it is interesting.

Mr. Wiles:

Of course, we want to show that this has been a problem ever since the industry started.

The Court:

I will let him go ahead, and he will come down to something more recent.

By Mr. Wiles, continuing:

Q. This process that you have just mentioned as shooting wells, that continued to a considerable extent up to rather recent times, did it not? A. Yes, it has continued right up to the present time, and is still in use. Shooting is not effective in all formations, either in all sandstones or all limestones, but it has favorably affected production, above the rate, and the ultimate recovery in many limestone fields.

Q. Is there a rather localized effect, close to the well, or can it be extended for a considerable distance? A. We know from measurements of the size of the hole after shooting that it has not enlarged the hole very greatly, that is where the hole was originally six to eight inches in diameter, it may enlarge it to some twelve inches, something like twelve inches, and occasionally eighteen inches, but it also cracks the rock, but how far it cracks it I do not know, and I have never heard any figures which would prove how far back it cracks it.

The Court:

Is there anything about whether or not the fact it might make a well to it,—like where you applied it to the stump out here or a hole in the ground? It doesn't take it with this rock, as I understand; it tends to split it rather than throw pieces back? A. It can't throw the rock back because there is no place for it to go, and it can't blow up because you have the formations holding it down, unless you put in an overcharge, and if you put in an overcharge, of course, it might do damage to the top of the well if the well was shallow. The figures I gave in 1917 were made in view of shooting the wells and the processes of increasing recovery except the use of injected air or gas, and except the use of flooding. In other words, they were for methods used prior to those two processes.

The Court:

Shooting them would increase it, it helped? A. Oh, yes, very greatly.

The Court:

What other method did you say besides the shooting of them? A. They used various methods for cleaning out the hole itself, and at a later date in 1869 they applied what is known, what they then called a gas pump which was a vacuum pump. And, the principle on which they operated was to remove the atmospheric pressure and permit the gases in the rock to expand an additional few pounds.

The Court:

You mean pump the air out and make a vacuum? A. There wasn't any here in the underground, but they made the casing head tight, and connected the pipe to the casing head and applied this suction pump to it. The vacuum has been used up to the present time.

The Court:

You made your vacuum above. Wouldn't that tend to make that oil come up? A. It would tend to make the oil flow more freely and expand the gas which was in the rock. You see, your oil is flowed from the pores of your producing formation in the wells.

The Court (Interposing):

Held under pressure? A. Originally, your oil with the gas in solution is under considerable pressure, and that gas expands and pushes the oil with it to the well from which it is lifted to the surface by either natural flow or various mechanical means. In time your natural gas forces become depleted and become ineffective until finally if you don't do something to replace these natural forces you wouldn't have enough force to force your remaining oil to the well. At that stage these old operators would go and put on their vacuum pumps, or gas pumps they then called them, and by removing atmospheric pressure it was the same as if they put into the sand another twelve or thirteen pounds of pressure, because it allowed the gas to expand against that much less pressure, and your gas in expanding had atmospheric pressure, which is about 14.7 pounds at sea level, and by using a gas pump you could remove that pressure from it and allow the gas to expand that additional amount.

Mr. Wiles:

Q. To get some idea of how important this vacuum is in per cent, proportion, what is the underground pressure likely to be like, say, at several thousand feet? A. The underground pressure, that is the original underground pressure has an extremely wide range. It is usually in approximate proportion to the depth, and usually it is

about 43 pounds pressure for each 100 feet of depth. That is an approximation which isn't true, but is generally true, so that the first wells, which were shallow, had original pressures of maybe less than one hundred pounds. In recent years where they have been drilling to great depths wells of ten thousand feet or more they have pressures of five or even six thousand, even seven thousand pounds initial pressure. So that pressure varies with those great ranges in accordance with the depth more than any other factor.

Q. In view of those figures, the 15 pounds difference that you can make with a vacuum would be rather insignificant, would it not? A. The amount of push which the vacuum or gas pump would make was not large and was negligible in the deeper sands. In some of the shallower sands it was rather important, but it could not be a highly effective process.

Q. Now, there is a process known as re-pressuring, is there not? A. Yes. The word "re-pressuring," I might say, is used in a good many different senses, but in the sense I believe you mean it is the injection of either compressed air or compressed gas into a depleted field. That is, instead of what you might say putting a pull on the sand by a gas or vacuum pump you can put a push on it by taking air or gas and compressing it in a compressor, and injecting it into one well and allowing it to flow through the sand into producing wells around it. And, of course, the pressure which you can generate in that manner is unlimited, whereas the additional pressure which you release from the sand by a vacuum pump was distinctly limited.

The Court:

I suppose you have tried to apply your air to some low place in the pool and get it out at a higher place? A. There have been various theories and the theories have been applied very largely in accordance with local conditions. In some pools it seems to be better to distribute your output and input wells, producing wells as they call

them, in some structure which seems to be best to put all your gas in the high part, and force your oil down so that the oil will flow with gravity in addition to the aid of your pressure. In other cases they have them put it in at the edge of the pool and forced it up. Generally the best practice, at least a practice which the engineers seem to agree upon, is to put it in the high part of the structure if there is a pronounced depth to the sands.

In limestone formations the repressuring systems have not been markedly successful. It has been tried in a good many cases, and it is very seldom successful. The reason seems to be that the pores in your limestones are of a different origin, and have a different nature than sands, and your air or gas will, of course, take the lines of least resistance, and usually in limestone there are channels of resistance which are so much less than the body of the limestone that your air and gas would pass through, doing very little good.

For example, in the Trenton pool, an application I know of, they injected the air into the formation, and instead of that air showing itself about the nearest wells, it followed a line across the field and appeared in wells a distance of a mile away, apparently having followed a fracture zone. That seems to be the most logical explanation. The exact conditions we were unable to get any proof of.

Q. There are methods also where you add water, are there not? A. Yes, instead of putting in a gas, you can put in a liquid, and practically the only liquid which would be commercially feasible was water. I do not know of any case where it has been very effective.

Also, prior to 1931 we used various reamers which would go into the ground and enlarge the drill hole from its six or eight inches to so much as three feet in diameter, that is, ream it out mechanically. That was used to a limited extent, and did some good. It increased production some, but not to a highly important degree.

There were also methods for removing the paraffin which would accumulate in the pores; that is, as the well

gets old, certain oils have paraffin waxes in them, which would separate out; and this paraffin would accumulate in the pores of the sands immediately around the hole and clog it up. There are various treatments for that, such as steaming it out, circulating hot oil, putting in chemicals, electrical heaters, which would remove the obstruction. That also applied to old holes where mineral matter had been deposited in the pores of the sands and clogged it up. To remove that they have put in light shots, which would crack it off.

Q. As far as wells in limestone are concerned, aside from the shooting process which came in, as you said, in 1865, was there any serious method developed that went into practical use to any extent? A. Well, up to acidizing, I don't recollect any methods which came into general use and were of any importance.

Q. When did proration come in? A. The first proration was generally effected about 1926 in Oklahoma and created a special reason for obtaining maximum daily production from a well. The formulas for prorating the production of wells were based upon what they call the potential of the well, either wholly or largely. That is, if the well had a capacity to produce, say, one thousand barrels if it were allowed to produce its full quantity, it would be given a higher allowable than a well which, say, could only produce five hundred barrels a day. So the incentive on the part of the operator was to put his wells in condition so that they would make the best showing when these potential tests were made.

Q. Now during this same time, do you know of processes for increasing the production of wells which were tried experimentally and abandoned? A. Oh, I used to hear of various methods and ideas of increasing recovery. Of course, it is my business—

Mr. Lyon (interposing):

Your Honor please, I don't think we ought, if this evidence is going to be used, to receive evidence about what this witness heard, which he characterized as abandoned or experimental.

The Court:

If it is something you dispute, I would adhere to that, I think.

Q. Name the methods you know about or which became known in the industry so that, as an expert, you would know about it? A. One of them I know of personally was the idea of heating up the rock by either forcing in steam through the producing formation or hot water or some other fluid which would be a conveyor of heat into the rock, the theory being that you thus reduce the viscosity of oil and also you generate gases from the gasoline which was a part of the oil in the rock. The idea was to pump the hot water in through the wells right into the formation.

The Court:

It would get cold before it could get down there. A. That is exactly what happened. All of those methods, however, were tried, and personally I made many, many calculations on them. They all failed because the mass of heat in the rock itself was so great that it was not feasible. One plant they tried it and got a good increase, but they found that putting steam into the rock, they found it took all the additional oil they recovered and all they produced before to raise steam to heat up the rock.

The Court:

What is the temperature down there a couple of miles? A. When you get down a couple of miles it is likely to be around 250 degrees Fahrenheit. One hundred feet down it will generally be the average surface temperature, which in this (Michigan) climate, if you average the year round temperature is about 45. That is my guess.

The Court:

You get down a mile and it would be how much? A. The general rule is that your temperature increases one degree Fahrenheit for every 70 feet of depth, and you start at the surface. That is, your average yearly atmospheric temperature becomes the temperature of the rock at about 50 to 100 feet below the ground, and your heat gradient, as they call it, begins from that point. Down south in

Texas the average surface temperature is around 75 and up here I suppose it is about 45, so you start with a temperature which is lower, but your increase is about the same.
The Court:

One degree for each seventy feet? A. About one degree for each seventy feet of depth. You have so much pressure your water couldn't boil. You get away above 212 degrees, only your boiling point has the factors of temperature and pressure.
The Court:

You mean you can't get steam down in there? Can you? A. In the shallow oil well they can insulate the tubing carefully, and get down there and insulate the rock. What happens is the steam gets in the rock, then it condenses, then it cools off, so all you are doing is increasing the cycle of water. You start with the steam at the surface of the earth and force it right down through the tubing of the well into the sand. It never has been tried on deep wells—only shallow wells. It hasn't been successful. It isn't practical.

Another method, to continue my answer to your question, is to mine the oil. That is, sink shafts down to the sand and drive tunnels along the sand and let the oil drain out. I have seen some of those shafts and tunnels. It is feasible at a price but it costs so much that it wouldn't be commercially feasible at prices we have had in recent years.
The Court:

I don't get the idea of how you would tunnel it. A. You would tunnel it as you would in a coal mine—sink a shaft and drive drifts. It has been done for years.
The Court:

Drive it out sideways? A. Drive it out sideways. There is considerable danger in it but they have means of overcoming that danger.
The Court:

How deep do they drive? A. They can go to as great a depth as they could in ordinary mining operations.

The Court:

Well, what is that? A. I don't know as there is any limit. The only limit is the temperatures they reach, and the cost. They have mines in this state over 6000 feet deep. This mining of oil was actually carried on commercially in France and Germany, where the price of oil was greater. In this country it is not feasible at present prices—purely a matter of cost.

The Court:

Then it goes out laterally? A. Then it goes out laterally, and they elevate it.

By Mr. Wiles:

Q. Now, taking the time from, oh say, 1910 or so, when the automobile began to greatly increase gasoline demand, what was the belief of the industry and of the government as to the future of the oil supply? A. The government and the industry generally went through a period of apprehensive shortage that commenced during the World War and continued for some years thereafter. That is, at that time they became conscious of the great need for oil and also of the fact that our oil fields were limited and sooner or later would exhaust. At that time there was a feeling that the period of exhaustion was quite close, was quite imminent. It wasn't until the late twenties that that apprehension was relieved, and they came to the conclusion generally we had more oil than we had originally thought.

Q. You have reserves in sight for many more years now than you had, say, in 1919? A. Yes, I believe we have.

Mr. Wiles:

I have here a Bureau of Mines Bulletin No. 177, published in 1919, and want to quote just one sentence, and I ask you whether this is a fair sfatement of the general attitude of the trade and government?

"At present the country is facing a serious shortage of petroleum. By way of preparing for the best way to meet this emergency, the Bureau of Mines has been carrying on technical investigations in the petroleum industry for several years." A. I believe that represents the majority of the opinion at the time.

Q. I hand you Bulletin 148 of the Bureau published in 1917 (PX-7). Is that your work? A. Yes, I wrote this while I was with the Bureau of Mines.

Mr. Wiles (reading from bulletin at page 7):

"In its efforts to reduce waste, and increase efficiency in oil production, the Bureau of Mines is investigating methods of increasing the recovery from the underground sources of supply, which are the foundation of the petroleum industry and the many allied industries wholly or partly dependent on it. In the face of a demand that is increasing faster than the production and that, in the consensus of opinions of well-informed authorities, is soon likely to outstrip the productive capacity, it is well to consider whether it is not possible to extract more oil from the known sources of supply. It is universally acknowledged that by the usual production methods much oil is left underground, the general opinion being that at least 50 per cent of the oil in a field remains unrecovered when the field is abandoned as exhausted. From the writer's own investigations he believes the average recovery is even less, and if any considerable portion of this oil being left underground could be made available it would have a tremendously favorable influence on the petroleum industry and all the industries dependent on it.

"In this publication are considered the principles involved in increasing recovery and methods of extracting more oil from the oil-bearing formations than by the usual ways of producing. These methods are: The use of gas or vacuum pumps, forcing compressed air or gas through the oil-bearing formations, displacing the oil by water, and better utilization of the natural pressures in the oil-bearing formations. Especial attention is being given to a process —commonly known as the Smith-Dunn—for forcing compressed air through oil-bearing formations because it is believed to hold most promise for the future.

* * * * *

"That much of the oil in a field is never recovered is well known, but how large a proportion is left underground

and the possibility of increasing the recovery cannot be fully realized until one clearly understands that the exhaustion of an oil well is due more to the exhaustion of the natural gas, which is the principal agent in driving the oil into the well, than to the exhaustion of the oil itself.

"Facts presented in this bulletin go to show that the capacities of the oil sands in the various fields of the United States are five to ten times greater than the quantities of oil commonly extracted from them. If it could be fully established, as seems most probable, that the pores of the oil-bearing sands were completely filled with oil at the time the fields were first developed, then 80 to 90% of the oil is left underground when the wells are abandoned. Although the evidence at hand does not permit positive statements that this proportion is being left underground, there is abundant evidence that much oil capable of being recovered remains in the sands. Complete extraction is not to be hoped for, yet there is no reason to conclude that the maximum possible recovery has been reached when the natural forces have been exhausted, and, furthermore, it has been demonstrated that it is practicable to get more oil from the sands by the processes described in this report."

(The bulletin was offered and received as PX-7.)

The Court:

Is there any reference in this book to the acid?

Mr. Wiles:

No. This was published in 1917.

The Court:

Didn't you know about the Frasch patent? A. No, I hadn't heard of it. During all this period up to, say, 1932 acidizing of oil wells was not one of the things that was known and used generally all through the trade.

By Mr. Wiles:

Q. When was it that you first heard of acidizing as a practical proposition? A. Well, I had heard of it—in fact, witnessed a test as early as 1918 on oil producing sandstone to knock off the crust, and again in 1922, something like that, for the same purpose. The first I heard

of acidizing on limestone formations was,—it must have been about 1932 or 1933. I can't remember the exact date. I first learned about the Frasch patent in connection with this case, within the last month.

Q. Within your experience now, how was acidizing received about when it was brought out in 1932? A. Well, it was received unusually rapidly for a new art in the industry. My experience at the Bureau of Mines where our principal function was to find and apply and introduce new methods led us to believe there was usually from five to ten years' inertia to overcome in introducing a new idea to the industry, and this was adopted much quicker than any other new idea within my experience.

Q. How soon was it,—how extensively did it become used in wells in limestone? A. Well, within a very,—only a matter of months, reports came in from almost every part of the United States where they had limestone fields. I think within two years I don't believe there was an area in which limestone production was important that I hadn't had reports that it had been used there.

The Court:

Well, we generally find seventeen years after a patent is granted the public gets the thing. What explanation have you got that that patent of 1896 didn't grow any fruit? Aren't you satisfied you could use, without any inhibitor, an acid to better advantage than you could blast or steam and these other things you have been telling me about? A. Well, it has been proved by experience that acidation is better than those other processes.

The Court:

Even if you didn't have the inhibitor? A. Well, I couldn't say as to that. Of course, the only thing I can say is that probably the early users of acid must have encountered so much trouble from it that they were discouraged, and these methods which were all coating pipe would not be such as would be practical in oil wells.

The Court:

They couldn't have tried very hard or encountered

much difficulty or the other hand of the government would have found out about it. Here is the patent hand of the government. The government has so many hands, they don't find what they have got in their pockets, but here is the Patent Office down there with this patent right on file in there, and you are right over in another branch of the government in the same city telling all these ways, and there is a better way than any of those you were describing right there, even if you did not have an inhibitor, I take it. Maybe I am wrong about it. A. I couldn't say as to that, whether the raw acid might do it or not.

The Court:

Have you got any of that history about that? Did you ever, you think, run into difficulty? I take it you are just theorizing about it? A. That is purely surmise. I have no history.

The Court:

Isn't there any available history about what that chap did with his patent, or what they did out in the oil fields? A. If there is I don't know about it. I haven't made any search for it.

The Court:

Do you know, was he an oil man? A. One of them, in fact both of them, were in the oil business.

I recall this Frasch patent. There is a possibility that the acid might eat around the packer.

By Mr. Wiles:

Now, my view about this is this: Frasch puts in his patent, and he was a great man and everybody looked up to him with the greatest respect, and he says, "You can't put raw acid down there or you will spoil your pipe. Therefore, you must pull your pipe, put down a rubber covered pipe, and then introduce it, and then take out the rubber covered pipe and put down your pump pipe again." Now, considering the expense of bringing this special pipe in adequate quantity, and the assembling and disassembling you have to go through, do you think such a process would be acceptable to the trade at any time?

Mr. Lyon:

I object to that as too speculative, Your Honor. The witness hasn't qualified.

The Court:

Overruled. I have invited the question, I guess. I will let him develop it. A. I don't know as to what they knew back there in '96 or what they had, but I think it would be very difficult even under present knowledge to work out a system which would fully protect the pipe in that manner and prevent corrosion.

The Court:

How much is a mile of pipe worth? A. Well, it depends on the size. Tubing, ordinary two inch tubing generally costs about 25 to 35 cents a foot, according to the quality and weight of it. A mile of pipe would cost say $1500, I should say off-hand.

The Court:

How long will it take that acid to eat through. A. I was going to add, if they keep that acid in any length of time it would be very difficult to get any protective which could be taken apart and put together again that wouldn't allow the acid at least to get into the seams.

The Court:

If you don't put the protective in there, how long would it take to eat through that? A. Oh, I don't know.

The Court:

Give me some idea? A. Well, I haven't gone into that.

The Court:

Days or weeks or hours or years or what? A. Well, I would say—I would have to more or less guess at it—I would say twenty-four hours, if the acid was left in the tubing, it would very likely eat through the walls.

The Court:

There may be some chap who had a poor well, a good sport like most of them have to be to put money down in the ground, who tried it out to see what would happen. A. They may have tried it. I don't know.

By Mr. Wiles:

Q. Now, can you tell us approximately the proportion of the oil production that comes out of limestone? A. Well, that is very difficult to get any precise estimates on and I haven't a precise estimate. All I can give you is the order of magnitude, and I would say it is about twenty-five per cent of the present daily production which is from limestone formations.

The Court:

Is this acid any good in sandstone? A. It has had, under special conditions, beneficial effects in some sandstone, where the sand contains a certain amount of carbonates, and in such case the acid may eat out this carbonate content and enlarge the pores and in that way increase the permeation.

The Court:

Has there been any other kind of acid they use for different kinds? A. Yes, they have other acids. They have proposed to use hydrofluoric acid which would eat the sand itself, but so far as I know that has not been satisfactory. It has not been practical. And they have mud acids which will eat a certain content of the mud which sometimes clogs the pores of the hole and which seems to be beneficial quite often.

By Mr. Wiles:

Q. Can you give us a rough idea of the price range of mid-continent crude for the period preceding 1932? Start with the Cushing pool in 1915 when prices were way down. A. I couldn't give you the exact figures. About all I could give would be some approximation. Prior to the Cushing pool the price ranged from a low of about 50 cents up to a little over $1.00. During the Cushing pool the price went down to a point where they were not quoted. Oil was sold at the Cushing pool at a net of 10 cents a barrel. That was sold in the tank, and when you took away the tank cost, the oil itself sold for about 10 cents.

Then in 1916 it commenced to go up again, and about 1917 it reached over $1.00. During the World War it was

artificially held down to I think $2.25. Then after the War it reached an all time high of $3.50 in 1920, I believe.

In 1921 the oil price took a plunge along with other commodity prices and it went down to $1.00 in the latter part of 1921 or 1922. Then it wavered back and forth reaching a high of about $2.00 and went down again about 1925, and in 1926 36-gravity oil went up to $1.86, I believe.

From 1926 to 1930 most of the time it was between $1.00 and $1.50 and it averaged about $1.25. In the latter part of 1929 or 1930 it started to go down again, and in 1931, on account of the flood of oil from the East Texas pool and also the depression, it went very low. In 1932, due to better control of production it went up again. In 1933 proration broke down and it went very low. Since that time, it has averaged about $1.00 or $1.10.

CROSS EXAMINATION

I was with the Bureau of Mines from the fall of 1914 to the fall of 1920, six years altogether. As to whether or not during that period there was any knowledge in the Bureau of Mines of the use of hydrochloric acid in an oil well to react on the formation, all I can say is that I do not remember of its having been brought to my attention. However, there could have been knowledge of it on the part of some of the individuals in the organization. I know a man by the name of Rollin Van Auken Mills. He was connected with the Bureau of Mines during the last two or three years that I was there. He was a petroleum engineer, and his field of work was research on the treatment of wells and oil recovery. I think his principal problem was on the paraffin troubles. He worked under my general direction.

I have seen a bulletin, serial number 2550, dated December, 1923, entitled "Reports of Investigations, Department of the Interior, Bureau of Mines, Subject, The Paraffin Problem In Oil Wells," by R. Van A. Mills. It was prepared after I left the Bureau of Mines, but I read it

afterwards, and I have read it recently. The work covered by it was started before I left the Bureau of Mines, under my general direction.

By Mr. Lyon:

Q. Well, now, this bulletin on page 9 has a paragraph entitled "Hydrochloric acid," and the text starts, "The Bureau of Mines has experimented with the use of hydrochloric acid," and so forth. Do you have any knowledge of the work that is referred to there? A. Well, I knew some of the work that he did before I left the Bureau of Mines; I know he had tried various chemicals in wells.

With reference to the patent issued to Mr. Mills No. 1,421,706, dated July 4, 1922, on an application filed October 15, 1918, I knew that he was filing for several patents, but I did not know just what they covered. He was connected with the Bureau of Mines on October 15, 1918.

Q. (By Mr. Lyon) This patent or patent application was dedicated to the public by Mr. Mills under the Act of March 3, 1883, as noted on the patent. Was that at your direction as head of the department? A. No, it wouldn't be under my direction, because I wouldn't have anything to do with the control of policies which refer to patents. I believe it was the practice of the members of the staff of the Bureau of Mines, while I was in charge, in filing patent applications to dedicate their use to the public under the Act of March 3, 1883.

Q. Now, this patent, on page 2, line 18, refers to the acid treatment of wells. Do you know what that refers to? A. I wouldn't know without reading the patent itself to see. There are two ways in which acid has been used in wells. One was the one I described yesterday as having witnessed in 1918 where it was used to remove the incrustations of mineral matter and mineral matter which had been deposited in the pores of sand. The other is to be used only in limestone wells, and I don't know what that refers to.

Q. Now, did you have knowledge of both of those methods while you were with the Bureau of Mines? A. The

only one that came to my attention while I was with the Bureau of Mines was the one for removing mineral incrustations in the sandstone wells.

Q. What is the difference in the action of the hydrochloric acid after you pump it down the well and force it into the formation whether the formation is sandstone or limestone? A. Well, only the chemical action depends on the materials in the well on which the acid acts. If there is any lime in the sandstone well, the reactions would be the same as if it was only limestone formation. That is, for that part of the reaction. Your reaction may also take place with other mineral matters in the sandstone well, which possibly might not be present in a limestone well.

Q. Then is there any sure distinction between these two methods that you have referred to or do they overlap and intermingle? A. I wouldn't say—of course, it is a matter of the structure of the reservoir rock. In one case the whole reservoir rock is soluble in acid, or mostly soluble in acid, and in the other you have a structure of insoluble material with a filling of acid soluble material or at least partly acid soluble material.

Q. Well, in either case the method is the same in the sense that you perform the same physical operations in introducing acid into the well and causing it to penetrate the formation, and the only difference is that the effect of the acid will vary with different formations; is that correct? A. Well, speaking broadly, I think that is correct.

Q. Now, as I understand you, even today the results of acidizing a well are not uniform. Some wells you obtain beneficial results and others you do not, is that correct? A. That is the general report, yes.

Q. And particularly true on old wells, is it not? In some old wells you can increase the production by acidizing them; others you cannot? A. It is variable, yes.

Q. It is also true on new wells. In other words, you may acidize the new well and obtain no beneficial results from the operation, is that not correct? A. That is true, yes.

The bulletin, Serial No. 2550, above referred to, was thereupon marked and offered as DX-8.

By Mr. Lyon:

Q. In your testimony, Mr. Lewis, yesterday you were asked: "Q. When was it that you first heard of acidizing as a practical proposition? A. Well, I had heard of it, in fact witnessed a test as early as 1918 on oil producing sandstone to knock off the crust, and again in 1922, something like that, for the same purpose. The first I heard of acidizing a limestone formation was, it must have been about 1932 or 1933, I cannot remember the exact date." Was this work by Mr. Mills which we have been discussing the occasion of your hearing of the acidizing in 1922? Is that the work that you referred to? A. That is what I had in mind, yes.

Q. That was the work that you referred to in your testimony of yesterday? A. Yes.

Q. It would appear from your testimony that you had had some earlier knowledge of acidizing, in 1918, is that correct? A. Yes, sir.

Q. Who did that work? A. While I was stationed at Bartlesville, one of the oil operators asked me to go out there and witness a test of a well by a couple of men, I believe they were from Kansas City. I went out there, and they poured some acid down in the well. I don't know whether it was inhibited, or not, but it made quite a commotion.

Q. Do you know what kind of acid it was? A. It was hydrochloric, I believe.

Q. What makes you believe it was hydrochloric acid? A. Well, just from the reaction, but I do not know positively. I did not pay much attention to it because it was just an experiment, and I was very busy with other things at the time. But I afterwards made inquiries to find out what had happened to the well.

Q. When, how long afterwards? A. A few weeks afterwards. I found out, or, I was told that they had treated a couple more wells, but the effects had not been worth while, and I heard no more about it.

Q. That could be true today, the same thing could happen today with the present methods of acidizing, using the present materials, could it not? A. You mean that no worthwhile results would be obtained?

Q. You could go out to some wells and give them a treatment, treat them, acidize them by these modern materials, and get no favorable results? A. That sometimes happens, yes.

Q. That is all you know about that operation in 1918? A. That is all I remember of. I do not believe there was any reports came to my attention after that.

Q. You say the results were not worthwhile. You mean by that that the action of the acid on the formation did not accomplish any useful or practical purpose, is that what you mean? A. The owner of the wells reported to me that the results were not worth while, meaning that they had not increased production enough to make it worth his while.

Q. You did not hear anything about any difficulty in connection with corroding the pipe, did you? A. Nothing came to my attention.

Q. How much oil, and what percentage of the oil in the ground is supposed to be recovered today, as compared to 1925? A. By the use of better methods, and because the fields naturally are more conducive to high recoveries, recoveries are much higher today than they were at the time that I wrote that bulletin. (PX-7.) I would say as an approximation that the average recovery was of the order of 40 per cent of the oil originally in the ground.

Q. Over what period of time? A. That is to exhaustion, by present methods which are in use. When I say that they are recovering 40 per cent from the ground, I mean within the economical life of the wells. For instance, the East Texas field was discovered in the latter part of 1930 and is still producing. There are various estimates as to the percentage of the oil in that field that has been produced up to date. It is about 30 to 35 per cent of its ultimate. That is due, in part at least, to the fact that the

wells are largely shut in, and not allowed to flow to their capacity, or to be pumped to their capacity. That is, they have gotten about a third of the oil out that I think they are going to get out. As to how much of all the oil that is in the ground they expect to get out, the East Texas field happens to be an unusually favorable field for high recovery, and it has been operated in such a manner that this manner of operation is favorable to high recovery, and probably they will get over 50 per cent of the original contents. I would say that this Texas field is a good example of the fact that I called attention to in my testimony yesterday of the obtaining of a bigger percentage of the oil in the ground now than was customary fifteen or twenty years ago. I have not heard of acidizing being employed in that field to any extent. I never heard of any acidizing there.

I know of the Signal Hill field in California. It has been a very remarkable field, an outstanding field in the oil industry in this country. They started producing in that field about 1920. That field covers the top, or mostly the top of one hill. My recollection is that about 600,000,000 barrels of oil has been produced from that one hill or one field. I don't know what proportion of the oil that is supposed to be in that field has been actually produced and gotten out of the ground. I have heard that it is cited usually as an example of the best recovery of oil that has been accomplished up to date in any given field. That it is the best recovery per acre, but as to the percentage of recovery I don't know.

My calculation of comparison in the amount of oil produced today as compared with twenty years ago, in comparison with what is in the ground was a broad estimate. I didn't go into details. I would not be willing to accept the Signal Hill field as having one of the best records in the oil industry in regard to per cent recovery unless I knew more about it, because they had a tremendous thickness of sand which would have given you that high recovery in barrels, but might have been a low recovery in per-

centage. As to whether the percentage recovery may have been very high, I couldn't say. I have no figures. I never heard of any of the wells on Signal Hill being acidized. It is not the kind of property that acidizing does much good on.

The Court:

The reason for that situation that you have just told us about is because the formation can't be eaten by acid, or what is it? A. Yes, sir. The formation is a sand and not a limestone and that is true, also, of East Texas. Yes.

By Mr. Lyon:

Q. Now, you gave us a figure yesterday to the effect you thought it would take about twenty-four hours for hydrochloric acid to eat through a piece of oil well pipe. You intend it to be understood that that was merely a guess, that you did not have any basis for that figure, isn't that right? A. That is true.

Q. You don't actually know the rate at which hydrochloric acid dissolves or corrodes iron, do you? A. I have looked that up at various times, but I don't remember it right now. I will have to look it up again.

I couldn't say whether, if you fill a pipe with hydrochloric acid, a piece of oil well tubing, there would be enough acid in it to corrode through the pipe before the acid exhausted its power. I understand that in this acidizing, they usually take precautions to see that the acid does not come in contact with the casing.

REDIRECT EXAMINATION

The case I spoke about in Bartlesville, where they put acid down a well, it was a sandstone formation, so that all it could have done would be to wash the surface.

In the Bureau of Mines, the Petroleum Division that I spoke of is subdivided at least so there is a department for refining processes, and one for production processes, and there are several others. The Bureau of Mines studies and reports on refining methods just as fully as it does on producing methods.

These fields Mr. Lyon asked me about as having particularly high production—East Texas and Signal Hill, both are sandstone formations.

The Court:

So far as this acid is concerned, you couldn't use it? A. Not this acid.

The Court:

It likes lime? A. Very fond of lime.

The Court:

And therefore it is useful, as I understand it, you get a sandstone with limestone formation in it, it will break that down and weaken it because it eats out the lime part of it, is that the theory? A. It has had a little success in sands which are cemented by lime.

The Court:

It would eat out the lime but wouldn't touch— A. —touch the sand, but it hasn't been generally successful.

The Court:

Let me find out what you think happens. Now, take the ordinary limestone, is it pretty pure so that it takes in this chemical and forms a new chemical? A. Yes, it forms calcium chloride.

The Court:

Well, would that be a liquid or solid? A. That is soluble in water.

The Court:

And is there water enough down there? Should I have a picture that it is eating this rock and then it is becoming filled with water in there? A. According to the statements made yesterday, they use a 12 to 15% acid—that means 12 or 15% of it is acid and the rest of it is water. So it is a solution of acid.

The Court:

And then they pump that out? A. They pump the spent acid out of the well.

Sometimes these formations we call limestones are dolomites, a mixture of carbonate of lime and carbonate of magnesium. Both of those dissolve in the same solution, except the dolomites dissolve more slowly.

The introductory paragraph of Bulletin 351 of the Bureau by Judge S. Rice, published in 1932, entitled "Mining Petroleum by Underground Methods," which reads—

"The methods of extracting petroleum from sands or sandstones of wells have been studied for years, but while methods have been greatly improved in the last decade the present percentage of extraction of the total amount of oil and sands according to various petroleum authorities is usually only ten to thirty per cent. If stimulative methods are used under favorable conditions the recovery may be greater," represents a generally accepted view as of 1932.

The term "sands" is used very loosely in this business, and is frequently used to cover limestone, or anything else, dolomites, or anything that is an oil-producing formation. It is sometimes used to cover anything that will produce oil, any formation.

JAMES W. REBBECK,

a witness called by plaintiff, testified as follows:

DIRECT EXAMINATION

I am employed at the Dow Chemical Company, Midland, Michigan, in the Patent Department, and have been in its employ since March of 1928.

I graduated from the University of British Columbia in 1920 in the department of Chemical Engineering with a

degree of Bachelor of Science. Then I entered the University of Toronto in the fall of 1920 to take some postgraduate work in chemistry there. I was attached to the faculty of the Department of Chemistry of the University of Toronto from 1920 to 1923, and in that interval obtained the degree of Master of Arts. From 1923 to 1926 I was on the faculty of the Department of Chemical Engineering at the University of Toronto. I also engaged in postgraduate work during that time in physical chemistry, colloidal chemistry and organic chemistry, and from the year 1920 to 1927, while at the University of Toronto I conducted a number of researches on the electrolysis of glass and some other subjects. After leaving the University of Toronto I entered the Mellon Institute of Industrial Research at Pittsburgh, Pennsylvania, and from there I went to the Dow Chemical Company as a research chemist.

In the beginning I was hired by Dow to engage in research on industrial chemical problems, particularly in connection with calcium chloride manufacture and uses, chlorine production, bromine production, iodine and other inorganic chemicals; and then I was transferred to the problem of corrosion, scaling, and other problems in connection with the power plant over there in Midland, Michigan; water purification. Then I was transferred to the metallurgical department, and engaged to study the metallurgical problems in connection with magnesium. Then I was transferred to the fabrication department handling the manufacture, casting, forging, rolling, and so forth, of magnesium and its alloys. That is what they call the Dow metal, that being the trade name for a series of magnesium base alloys manufactured by the Dow Chemical Company.

Thereafter I was transferred to the patent department, and began studying the patent art relating to magnesium. From that I entered the patent angle of the business of treating oil wells and gas wells, and related wells. That necessitated studying the patent art relating to those matters. I made a number of compilations of United States patents in that field.

The files of the Dow Chemical Company in that line and in other lines relating to the production of oil are complete, so far as I know, in that special phase of production wherein a well is treated with some material by introducing the same into the well. It includes in connection with that other related topics, such as repressuring, the use of heat in oil wells, chemical and non-chemical solvents. I haven't a complete collection of the publications in that line, but the patent collection, so far as it relates to the use of materials in wells for some purposes is believed to be quite complete.

I have heard most of the testimony of Mr. Lewis regarding various methods which have been tried in this country for increasing the production of oil and can refer to patents illustrative of the various methods to which Mr. Lewis referred. I brought with me a collection of United States patents that represents a selection of a much wider and larger number of patents, and these, I believe, are very typical of the sort of patents in this field. For simplification in considering them I have classified them into six different groups, main groups. The classification that I have adopted is as follows:

First, the use of heat in a well, and I have subdivided that into 3 groups, where the heat is generated in the well, or, 2, generated in the formation, or, 3, where a surface heated heat transfer agent is introduced into the well.

The Court:

What does that middle one mean? A. That is where the heat is produced. Passing an electric current through the rock is an illustration of the middle classification, namely, the generation of heat in the formation.

The second main division is the use of solvents, and these may be subdivided into two classes—first are chemical solvents. For example, hydrochloric acid, which chemically dissolves the rock; and, second, nonchemical solvents such as gasoline and the like, which works like water on sugar.

The third main division is re-pressuring. The fourth,

flooding. The fifth, vacuum. Then the sixth is the catch-all, or a miscellaneous group, such as the use of hammer blows; another is a type where water is flowed toward the well, and, according to the theory of the inventor, the water is supposed to carry oil with it by adhesion. Another example is a patent issued to Van Auken Mills, about whom we heard some testimony; and that has to do with preventing water infiltration into wells, although there is an incidental mention of the use of acid, the purpose not being stated.

I have not included mining operations in any of these classes. As I said before, these are in connection with patents wherein something is introduced into a well. Now, I do have some information about patents on mining. I have here a collection of patents, maybe some twenty-five or thirty of them, more or less on the subject of what might be called oil mining, wherein one carves out the oil bearing earth or rock to recover the oil from the carved-out portion; or produces caves, channels and the like in the oil bearing rock to produce drainage galleries, through which oil may be collected and be brought to the surface of the ground.

Q. Will you proceed with your classification, and call attention to the approximate number of patents in each class, and select one of them as typical, and explain it to the court, please confine your answer to patents issued priod to 1932. A. Under the use of heat, my first classification, Subdivision 1, a typical example is an early patent issued to Edward L. Roberts, patent No. 47,458, dated April 27, 1865. This device is for bringing an explosive charge into the bottom of a well where it can be exploded and shatters the rock. Now, A. E. L. Roberts, I am advised, also obtained a patent on his method in 1866, patent 59,936, copies of which are on order at the patent office, where I would be able to show that he had a patent on a method of increasing the capacity of oil wells, which was based upon the use of a device of this kind, or the shattering of the rock by an explosive.

Another example of a patent in this class, one issued to

Butler G. Noble, No. 105,590, dated July 19, 1870, from which I quote the following: "Many wells after yielding oil in large quantities, gradually diminish in productiveness and ultimately cease to produce in paying quantities. This failure in yield is not always because of exhaustion of supply but results from the clogging up of the seams or natural ducts leading into the well bore by the deposition of paraffin and perhaps other carbonaceous matters." And he proposes to generate heat in the well hole to melt out these deposits, heat being generated by the combustion of slow burning gunpowder or something of that type.

Another example more or less typical in this field is the patent issued to James Dickey, No. 106,793, dated August 30, 1870, for improvement in removing deposits from wells, and his proposal is "introducing the gas to the top of the well and firing it thereat. When the well is cased it immediately ignites the deposit in the interior of the well casing and burns downward consuming as the fire moves downward, and the burning ceases when the paraffin is consumed." That was to take it off of the inside of the tubing. The gas referred to here is something which would support combustion. It isn't the gas from the well. The gas that is introduced here is for the purpose of setting fire to the paraffin deposits which are in the well. His invention is based upon this, in that it consists in burning out the paraffin by means of oxygen or other combustible gas introduced into the well by pipe or otherwise, and igniting it in the presence of the paraffin so that it would be necessary to put in oxygen or air, or some combustion supporting gas, in order to carry this process out.

I had reached the Oliphant patent, Oliphant and Lyddon, No. 797529, in which he proposed to set a fire in the well, which would have the effect of increasing the production.

I will now go to the second section of my classification of this first group of patents, involving the use of heat, wherein heat in this instance is generated in the formation itself, and, as an example I refer to Gardner 1,372,743, is-

sued March 29, 1921. He proposes to pass an electric current from one well to another, thereby generating heat within the earth formation, and that will serve the purpose of moving oil towards the collecting well. He connected the output terminals of an electric generator to the tubing of two wells, that is to say, the positive terminal of this output generator was connected to one of the wells and the negative terminal to another well; the generator, the two wells and the earth formation forming the complete circuit for the passage of the current through the earth. The Court:

Well, how would they fix it so that it wouldn't start to cross long before it got down to the bottom of the tube? A. I don't think he could prevent that. Nature would decide where that current is going to go after it goes in one well and crosses to the other, the path it takes between the two is not under control. You have no control of that. The patent states: "The operation of my improved system for removing obstruction to the flow of fluids in earth strata is as follows: An electric current of sufficient voltage to overcome whatever resistance there may be in the circuit described to maintain a watt output power to increase the temperature at the bottom of said well and in the strata between said wells to a degree sufficient to liquify paraffin, asphaltum, and other obstructing residue of petroleum, and to increase the gas pressure by heat, thereby forcing or blowing movable detritus from out the interstices and crevices of the rock adjacent to said wells."

I come to a new section now where the principle of operation is to convey heat into the well by something that had to be heated on the surface of the ground. A simple illustration of that is the Phlager and Lobdell patent, No. 56,987, dated August 29, 1866. In this case the method of conveying the heat to the bottom of the well is analogous to the hot water coil in a hot water heating system. There is nothing to indicate how deep a well they had in mind. However, if one considers the date of issue of this patent it must be with reference to such wells as were known at the time.

My understanding of the depth of those wells is that they were relatively shallow. I think the Drake well was 70 feet and other wells were drilled about 450.

Patents of this same type were still issuing as years went on. Here is one dated November 4, 1930, to C. Larsen, No. 1,780,428, the purpose of which was to clean the bottom portions of the oil well by the dissolution and mechanical removal of obstructive matter such as mud, paraffin, bentonite, salts, asphaltum, and other things which frequently fill the crevices and interstices of the formation and thereby prevent the oil from flowing into the excavation. He attains this object by producing in the bottom portions of the well a whirl or vortex of a hot fluid fraction. That is accomplished by lowering a device into the well on the end of a tubing, a device of laterally arranged jets whereby steam is forced down the pipe, force the pressure down into the well and squirt out into the hole.

Now, I pass over into the next group, the major division group 2, under the heading of "Chemical Solvents." I would prefer to pass these over at the moment, as I intend to refer to them later, and go to the patents in this major group, the second division, involving the use of non-chemical solvents, by which I mean solvents of the type that take into solution certain materials without undergoing chemical reaction with those materials. Water would not be one of these, because water as far as I know dissolves very little, if anything, in the base of an oil well, or similar well. If you had a lump of dirt down in there, water would dissolve the lump, but not in the sense in which I am using the word; that is, for example, the operation of taking sugar into solution in water, that is the kind of a solvent I have in mind here, and that reflects the type of solvents that are shown in these various patents. They are solvents that truly dissolve some of the substances in the base of the well.

The most typical of these I have here is a patent issued to Edward A. L. Roberts, No. 119,884, dated October 10th, 1817. He sets forth the well known problem that some of

the others set forth, that the oil bearing rock becomes gradually chocked up by the accumulation of paraffin and other substances contained in or deposited by the oil, so that the yield of wells after a time gradually decreases, and he suggests to employ what is here called benzine as a solvent for dissolving those deposits. And, of course, that merely means a distillate from petroleum gasoline.

The Court:

Maybe to somebody else that sounds just as impractical as the heating method, but to my mind that sounds better. A. This is much better. I know this type of thing is used today for the waxy or paraffinic deposits.

The Court:

I think that sounds as if it might be practical for the thing it is intended for? A. Yes, it is. Coming to the third group here classified by me as re-pressuring, the first one I have here is to Mark D. Mitchell, for oil flushing system, patent No. 825,745, dated July 10, 1906. According to this specification, the method embodying the features of the invention consists in supplying and driving the medium under pressure to the oil bearing stratum, within an effective radius or proximity to one or more oil well pockets. The compressing medium used for this driving effect may consist of air, gas, or other fluid, to which may be imparted a force sufficient to overcome any laxity in the forceful operation desired in the pocket or chamber by an extended, long conveyance to the hole or opening.

That art continued to develop, patents issuing, for example, to I. L. Dunn, 1,067,868, dated July 22, 1913, in which he proposes to pump back into a well a quantity of gas until he restores the pressure. He proposes to pump gas back into the formation where it re-dissolves, dissolves in oil, and then after he has thereby restored the rock pressure, then he will open the well and allow it to produce. Of course, he would get back some of the gas that had been pumped in, but after a time the oil would enter the well because it would be carried through the hole by the gas seeking to escape from the oil in which it had dissolved. This

one is not the drive type. The drive type I think is the one that was referred to by Mr. Lewis, wherein the repressuring gas is put inside, put into certain wells, but the oil is recovered from some other, to which the oil was driven; but in this instance he puts the gas down the same well that he later withdraws the oil from. Now, the patentee states that natural gas may be the pressure medium employed "or I may use any other permanent gas which may be cheaply manufactured but preferably I employ air which when forced into and through the rock upon its return not only has the effect of driving out the oil but also absorbs the lighter hydrocarbons to a greater or less extent thus becoming an inflammable mixture which may be burned or used for any of the other purposes to which carbureted air is put or, if preferred, the gasoline or other hydrocarbons contained in the air and which are capable of condensation at ordinary temperatures may be condensed, the air thus forming a convenient source of volatile hydrocarbons."

Now, this pressure restoration or injection of either air or hydrocarbon gas as the case may be, is effected by large pumps and that is being done on a large scale in many fields. They use several thousand horsepower of compressors turning gas back into wells to re-pressure pools. Of course, this process is directed to a single well, but a whole pool may be re-energized this way. The injection pressures used may run up to two or three thousand pounds per square inch, and they use two or three stage compressors to reach that pressure.

Regarding the length of time that will be consumed in making one of these repressuring operations, the patent states beginning on the last line, column 2, page 1—"But in any event the forcing is ordinarily continued until the required pressure is attained and may extend over a period of several weeks, months, or even longer. During this forcing operation, of course, every effort is made to retain the pressure and prevent the gas escaping either at any of the wells or elsewhere."

Mr. Lyon:

Just for the purpose of the record, your Honor, can the witness identify for us a particular location or particular type of operation as being used such as he has described, so we will know what he is talking about? A. I have reference to some of the recent issues of the Oil and Gas Journal. In fact, you can find advertisements on these repressuring pumps in almost every weekly issue that comes out.

Patent 1,735,646 dated November 12, 1929, issued to James O. Lewis, is another example of repressuring. The particular feature of this invention is a method of using air and natural gas alternately and in such manner as to avoid the formation of explosive gas mixtures during the injection.

As to whether that was the Mr. Lewis who was on the witness stand, there is no way of telling that from here, other than the printed matter which appears on the copy. I will read that. "James O. Lewis, of Tulsa, Oklahoma, assignor by mesne assignments to Dunn & Lewis of Tulsa, Oklahoma, a partnership, composed of Ervin L. Dunn and James O. Lewis."

Mr. Owen:

That, I think identifies him, Your Honor, he having testified as to that firm name.

The Court:

Yes, and that his name was James O. Lewis.

Another patent, issued in this classification is 1,816,260 dated July 28, 1931, to Robert Edward Lee, in which he proposes to drill lateral channels from a well at one level in the producing formation and then another set of lateral channels in the same formation at a lower level, and then inject gas from one set of channels to the other to force the oil out. And this type of thing continued on until I have here a patent to Robert E. Strait of Bartlesville, Oklahoma, assignor to the Empire Oil & Refining Company, 1978655, dated October 30, 1934, issued on an application filed November 27, 1926. That keeps it within the date that you

have requested, Mr. Owen. This has to do with increasing the production of hydrocarbons from oil wells in which a gaseous pressure medium is forced into hydrocarbon-bearing strata penetrated by the wells.

That now brings me to the patents in Class 4 entitled "Flooding." In this connection I might state that I have very few patents, in fact, I only have three. But it illustrates the fact that there are such patents, and, of course, we know there are such processes. This patent in this class, which is an indication of the type of thing, is 1,651,311, dated November 29, 1927, to Howard Atkinson, for recovery of petroleum from oil bearing sands. With reference to this invention of his, in connection with oil bearing sands, from which it may be difficult to extract the oil. He means sands in the broad sense. It may include acid soluble production formations, or non-soluble, or both. However, the use of this type of process has generally been confined to such formations as are practically not soluble in acid, as the sandstone comes within the type of porosity enough to carry out one of these processes, whereas limestones are like this desk, they are very impervious, they may crack, but they are not very porous.

Mr. Lyon:

Do you have in mind in that connection the flooding as they practiced it in Pennsylvania for forty or fifty years, to increase the production of the wells there? A. That is the type. This patent is not a very good example of that, because it relates to improvements in connection with that. It is not the first or earliest patent on this subject. In the patentee's words, he states:

"The object of the invention is to provide a method whereby oil or petroleum may be extracted with facility and in profitable quantities from oil wells from which oil has been extracted until they have ceased to produce oil in what is generally considered to be profitable quantities, and especially from oil wells which have become flooded with water and abandoned, as, for example, so-called edge water wells. * * *"

"The present invention provides a method whereby a large quantity of the oil which will not drain naturally from the oil bearing sand and hence remains after the extraction of oil therefrom in the usual way has been completed is recovered. It is based upon the discovery that when a mass of sand wetted with oil or petroleum is at ordinary temperatures submerged in water to which is added any strong alkali, the oil contained in the sand is within a short time removed from the sand in a body, leaving the sand practically clean and free from oil."

The Court:

Tell me in your own way how it is that they propose to get the oil out of this rock. A. They will introduce into one or more wells this water, and while that is going on they will pump other wells in the vicinity of the injection well. They put that water in under pressure, if necessary. In some instances they let it flow in by gravity from an upper stratum. The water stratum up above might be tapped by holes in the casing and let that water run down and it will enter the oil bearing stratum below and force the oil into the recovery well which can be collected in this pool.

Mr. Lyon:

What you call water drive, isn't it? A. That is the common term, yes.

The Court:

They put the water, we will say, into this hole without pressure, the tendency would be, if nothing happened, for it to rise to an equal height in some other well that they pumped the water out of. A. Yes.

The Court:

And the tendency would be that as it picked up the oil on its way, the oil being lighter would go to the top of that, I suppose. A. I think that would be a correct theory of that.

The Court:

With some success, possibly.

Mr. Lyon:

Of which you take judicial notice. It is in the 1880 census. They published an elaborate book or volume of the 1880 census describing all the methods that the Bureau of Mines then knew that they were using in the oil industry in the United States. You find a full account of this water drive in there.

Mr. Richmond:

The idea is to put in your water over one edge of your field or whatever you are going to drive for, and drive it towards your next well, and when the water shows up there you go ahead and put your water in there and go ahead and take it out of another well.

The Court:

How far? It wouldn't exceed a mile, would it?

Mr. Richmond:

I don't think it would be that far, Your Honor. I don't think it would be over a quarter of a mile.

Witness continuing:

I believe we have covered enough as to flooding to illustrate the type of process that is, and now we come to this last, second to last group, namely, No. 5, in which I have put the vacuum type process. I have one patent here illustrating that, No. 1,858,847 dated May 17, 1932, to P. L. Young. He proposes to connect the well casing to vacuum pumps and at the same time by the injection of a gas down a tube and through nozzles in the bottom of the hole, to create suction down there. They are both doné in the same hole. He is withdrawing a gas from the hole at the same time that he is using a gas jet pump in the bottom of the hole. He is producing the maximum possible vacuum at the bottom of the hole because it is there that he operates this jet pump which does the sucking, in addition to the vacuum pump that is at the top of the well. It aids in getting the most reduction in pressure that he can get in a well hole.

The Court:

Does it mean, then, that he has a suction at the top and

there is another suction at the bottom? A. It makes it easier for his purpose apparently to do it that way. But, he cannot, in any event, secure a greater reduction in pressure than the lifting off of the atmospheric pressure. All that anyone can do with a vacuum pump is hold off the atmosphere, and that is all he is doing but in a complicated way.

The Court:

He was figuring, perhaps, that the suction of his pump at the surface wouldn't be big enough so that when he got to the bottom of his well his vacuum wouldn't be very good. A. There is something in that, I believe. He states in his own words that, "The present method is an improvement of the processes for obtaining gas and vapors from oil wells under high vacuum by which higher vacuua may be obtained in an extremely efficient manner directly on the producing sands." That is his view of what it is he is trying to do. However, this patent is illustrative of the fact that there are patents in this field of vacuum operation of wells.

Then that brings me to a miscellaneous class of more or less unrelated things that might be done in an oil well in connection with extracting oil from the ground. The first one of these is dated 1865, No. 49,922, to Isaac Relf, and it involves the use of pressure produced by hammer blows of a piston inserted down the well hole. That was just to compress the air, making shots of compressed air at the bottom.

The Court:

Awfully small around the opening. Isn't that what he is hoping for? A. That is what he is hoping for. It has almost a mechanical way of getting the action of an explosive.

The Court:

In other words, it is different from what you had before of compressed air? A. Yes.

The Court:

But this is to compress it in shocks? A. That is the sort of thing it is.

The Court:

I should think that would almost come under compression, that is, air compression, or something— A. Yes, it could be, although it is a mixture of the mechanical and so on.

The Bureau of Mines has put out a publication dealing entirely with the vacuum operation of wells, and it is a better publication of that art than one could find in the patents themselves. I believe the date is about 1930. It summarizes the past history, of course. It shows that vacuum has been used on wells for many years in different places, as one of the methods of stimulating the recovery of oil.

Mr. Owen:

I am now going to make the offer of the copies of each of the patents referred to by the witness, merely for the purpose of illustrating what the witness has testified to, and for the convenience of the court, if he cares to look at them. When it comes to an appeal record, I, of course, do not expect to put them in.

The Court:

I will say this about the appeal record, they are not to be printed in that record.

That would be too expensive, and you ought not to do it. I have the privilege of looking at these in connection with this testimony. I doubt if I will find occasion to do it, but I have that privilege, and I reserve that same privilege for the Court of Appeals.

The Court:

By the way, which one of these classifications now does our method here in suit fall into? A. That was under the solvents, and I excluded that class from my discussion.

I can't place an exact number on the patents in these classes. But as I said before I believe my files of patents relating to the production of oil by means of wells cover some two thousand or three thousand patents. Those specifically directed to methods of treating wells involve some two hundred patents and, of course, the ones that I selected

out of that are a smaller number still. But, I did not include in the patents referred to those involving the use of chemical solvents. This will be up to June 30, 1932.

Mr. Lyon:

Are these all the patents there are in the Patent Office on those subjects, or just the number you happened to have when you made the estimate? A. Those are all I have found in connection with my business of locating these patents.

Mr. Lyon:

Now, similar patents or patents on this same subject have continued to issue since 1932, have they not? A. Oh, yes, indeed, and are still being issued today. There has been an enormous increase in the rate of issuance of patents since the issue of Patent 1,877,504. That is the Grebe-Sanford Patent in suit.

Mr. Lyon:

You mean in all of these different fields? A. No, in the special field of the use of acid in a well.

Mr. Lyon:

But how about these other fields; have the patents continued? A. They have been coming out, but I don't believe that the rate has been anything like—there has been a growth, of course, but the rate of growth there is nothing like what it has been in that special art.

Mr. Lyon:

What I am getting at is this: Since 1932 patents have continued to issue in these classes that you have mentioned here today, at least as fast a rate as they did before 1932, and to some extent faster? A. I think that is correct, although I haven't specifically computed those rates.

By Mr. Owen:

Q. Now, will you take up the field of patents in which solvents of one kind or another are used and which I understand you omitted from your previous classification? A. I omitted the solvents which I have called chemical solvents wherein the solvent action involves a chemical reaction, too.

Q. Will you take up that line of patents and explain

approximately how many there were prior to 1932, and what they cover?

The Court:

Does this question apply to just chemical solvents, or all kinds of solvents?

Mr. Owen:

Chemical solvents.

The Court:

That means where there is a chemical reaction?

Mr. Owen:

Yes, Your Honor.

A. My recollection as to the number is that there are about ten such U. S. patents. I may be in error by one or two, but they well—the correction will appear as we go on.

Up to June of 1932, or the filing date of the Grebe-Sanford patent in suit. The first of—

Mr. Lyon:

(Interposing) Would you give us at the same time the number that have issued since? A. Yes, I can tell you approximately. I think there are 71 more issued from the period of—that is, on applications filed since June 30th, 1932, until some time in 1939, there were about 71 patents issued on applications filed during that interval, while there were about ten patents issued on applications filed in all the previous interval up to that time.

Q. (By Mr. Owen) And what is the distinguishing feature that applied to those ten patents issued prior to 1932 and those 71 patents which have issued since on applications filed since 1932? A. I am not sure that I understand the question, Mr. Owen.

Q. Did all of them utilize acid in a well for one purpose or another? A. Yes.

Q. And then, as I understand you, the number of patents in which acid was introduced into the oil well, or any other kind of well, prior to 1932, was ten, and that since 1932, the year when the Grebe-Sanford patent issued, there have been 71 patents issued in that respect?

The Court:

Eighty-one; 71 on applications filed since that date, and ten on applications that had been filed prior to that date.

Q. (By Mr. Owen) Do you understand? Is that right? A. That is my statement, subject to perhaps the correction of a few numbers one way or the other.

Mr. Lyon:

Your Honor, can I ask a question? Are you speaking now of all patents using acids to dissolve formations, or wax, or some material on the formation, or are you talking about all patents involving any kind of chemical solvent, whether it is the acid or not? A. My number I gave was limited just, subject to correction, to such patents as involved the use of acid in wells for any purpose. They are limited to acids with or without other things.

Mr. Lyon:

Aren't there a great many other patents that show one kind of chemical solvent besides acids for use on a well. A. Not as far as I am aware.

Mr. Lyon:

Have you looked for them? A. Yes, sir.

The Court:

Just give one example of what you have in mind?

Mr. Lyon:

Some of these Tretolite patents. Tretolite Company has a whole line of patents for paraffin removing that are not all limited to acids. A. I don't know of any that are involving the use of acid in a well.

Mr. Lyon:

That is where I am mixed up here somewhere. They have a line of patents on the use of solvents for putting down wells, have they not, the Tretolite Company? A. I am not aware of it, that they have such a line.

Mr. Lyon:

Well, they have. As you say, has your search been such that it would reveal whether they had any or not? A. I believe it would have.

Mr. Lyon:

Then you say they have not any patents on solvents for removing paraffin from wells?

Mr. Wiles:

He said chemicals.

The Court:

Chemical solvents? A. I do not know of any.

The Court:

Just call his attention to one.

Mr. Lyon:

I have not got them here. I will have to get them and give them to Your Honor. There is a whole series of them.

The Court:

Then you find one and bring it here before you get through with it, and call it particularly to his attention.

Mr. Lyon:

Yes.

Mr. Wiles:

The witness has limited this to chemical attack.

The Court:

That was the reason I did not know but what there was some misunderstanding.

Mr. Lyon:

I think there is.

The Court:

I think it would be better if we could solve it at an early time. As quick as you find a patent that will illustrate what you are asking him about, call it to our attention.

Mr. Lyon:

Are these chemical solvents limited to those that will attack paraffin?

Mr. Wiles:

They will attack something—

Mr. Lyon:

For instance, mud, in a well, a well is muddied up, and you want to get some of that mud [redacted] as to open it up so that it will flow better. They use a chemical for that.

Mr. Wiles:

Chemicals that will attack something and make a chemical change.

Mr. Lyon:

Then maybe I have misunderstood you.

The Court:

That is not the chemical solvent, is it? That is what I was in doubt about. They explanied to me a little while ago, and I think I was asking some questions that if mud does not enter into a chemical change, but it just entered into a solution, or whatever you call it, it would be in the water, and that would suspend—is that right? A. That is right.

The Court:

That would be anything that would soak mud up, soak down the lump and let it float around in there, but that would not be included in the chemical solvent any more than it would if they put water in there and stirred it up?

Mr. Lyon:

(To the witness): Is that the reason that you eliminated from this class some of these Tretolite patents, or didn't you look at the Tretolite patents? A. I believe I have a couple of hundred of Tretolite patents in my collection, and I looked at them.

Mr. Lyon:

Some of them would have come into this class if it were not for this feature of solution? A. I can think of one or two that might have. There is one of the Tretolite patents—I don't recall the exact date, whether it is 1931, perhaps, or 1933, somewhere along in there, which involves the use of minute amounts of carbon tetrachloride in the water introduced into the well while it is producing, to prevent the formation of paraffin deposits. But, as far as I am aware, there are not any Tretolite patents that have to do with the use of an acid in the well for any purpose, or that have to do with increasing the production of a well in any way.

Mr. Lyon:

Do you happen to remember one, a Roberts patent, on putting a modified fatty acid down the hole to prevent the formation of emulsion that would interfere with the production of oil? A. I think there are quite a few such patents. As I understand their disclosures, they have to do with treating wells that are producing and while they are producing. It has nothing to do with the art that I have collected here.

Mr. Owen:

I have a chart, if Your Honor please, prepared by the witness to illustrate the point that has just been brought out. It is a little bit out of the order in which I intended to produce it, but in view of the fact it has now been brought out, I will have this chart marked Plaintiff's Exhibit 9 and will ask the witness to explain what it shows.

(Marked Plaintiff's Exhibit 9.)

The Court:

I will say this to counsel for Halliburton, any time you find such a patent I will be glad to stop and let you interrupt to let you show it to the witness and inquire about it, if you do find it.

A. This chart shows by this scale on the left the number of United States patent applications which issued into patents. The scale along the bottom is the year, corresponding to that number. The curve has been plotted with reference to these two scales, beginning in the year 1865, because that was the first year at which I found an application issued into a United States patent mentioning the use of an acid in a well. That was the Sherwood patent, issued in 1865. Then around this time (indicating) more patents issued, and as more issued and as time went along, this curve went up very slowly.

By Mr. Owen:

Q. How many had issued up to 1900, say? A. By 1900 there had been 5 patents issued on applications filed up to that time. Then we come to about what appears to be 1922 on the chart we perhaps have six or seven patents

issued by that time, six perhaps. The exact number we can determine by a reference to the issued patents and counting them up. We get along to 1930, there were then 10 issued patents on applications filed up to that time, and then I believe there were no more issued until the Grebe and Sanford application was filed and issued. Thereupon there was an enormous immediate growth in the number of applications issuing into United States patents, so that by 1939 there were more than 55 patents that had issued on applications filed up to that time.

The line indicating the issuance of patents involving the use of acid in a well since 1932 does not include patents that issued on applications filed by the plaintiff, The Dow Chemical Company. From this chart have been excluded the plaintiff's applications. But in the numbers that I have previously mentioned in my testimony I have included all the patents that I know about.

The Court:

You say you excluded applications of The Dow Chemical Company? I understood this was a chart of patents issued? A. Yes.

The Court:

Does it include patents issued to Dow? A. Only the Grebe and Sanford. And this chart shows nothing about pending applications. These all have become patents. The chart is according to the dates when the applications were filed. It is patents issued but it is by filing dates. The chart does not include any application which is still pending nor any application which has been rejected and abandoned during this period, because my numbers are taken from issued patents.

The Court:

But you have gone into this and if I were to make another little dotted line here (indicating) that showed the date patents issued, that would come clear up to today over into the '41 column, it would be here? A. Yes, sir. As a matter of fact, the steepness of the curve which shows the rate of growth might be steeper than this is, because that

might bring out still more patents pending we don't know anything about.

By Mr. Owen:

I have another chart which I will ask to be marked Exhibit 10. (Exhibit 10 marked.) This chart will be referred to as Streams of Knowledge Chart. I will ask the witness to take up, first, the patents which are listed under the title Stream 'B Knowledge of the Use of Acid in Oil Wells, in view of the fact we have just been considering that subject. That is the column on the right of the chart. A. The first patent in that column is 57,982 dated 1866 and it is for improved method of removing obstructions from oil wells. That patent teaches to bring acid into contact with an obstructing tool which may be in the well hole, for the purpose of eating away either the tool or the surrounding rock, or both.

The Court:

You can loosen it and get it out? A. Yes, or if you wish, you may dissolve the tool completely in the well hole. The corroding and the decomposing action of sulphuric acid upon iron and steel is well known and it is used in this process, or any equivalent acid. The acid is brought into contact with the obstruction by means of a small tube, and then—or, it may be brought into contact with the obstruction by means of a glass bottle or cylinder, the bottle being allowed to strike the obstruction and break, and empty its acid contents on it, thereby dissolving and making it possible to remove the tool. The acid is described as hydrochloric. That would take care of hydrochloric particularly, as it has a similar economic status and it is presumed to be similarly corrosive. It was broad on any kind of acid that would eat iron.

The Court:

Or any kind of rock? A. Or the rock.

The Court:

So that if they had a rock that some acid was particularly good for, they could use that kind? A. That is true. As he states,—"The acid will also act upon the rock

and will decompose portions thereof in which the tool is wedged and thereby quicken and render more easy this method." He also states in connection with introducing the acid, a copper barrel may be used to lower the acid to the obstruction.

The next patent on the list is dated 1873 to Looney, No. 139,010. His application was filed in 1872, and he makes use of an acid in an oil well to generate heat by reacting the acid in the well hole with an alkali. Potassium hydroxide is the alkali, although the patent uses the old language, a solution of potassa. That substance, of course, is a solution of potassium hydroxide.

By Mr. Owen:

Q. What does that patent have to say about how the acid is gotten into the well? A. I don't recall finding any special instructions about introducing the acid into the well. It should be noted, however, that he first places in the well this alkaline solution, and, of course, that will neutralize the acid subsequently introduced. That would not be an inhibitor.

The Court:

What would you say it did? A. It would neutralize the acid. That is just another way of saying it would react with the acid and turn it into something else which is not an acid.

The Court:

The purpose of this, what you have got I see is by that reaction to produce heat and melt something that they thought would plug it up somewhere? A. Yes. The patentee states that his invention relates to cleaning the well of paraffin and other similar resinous compounds which impede the free flow of oil by means of chemical ingredients, and it consists of what we have just mentioned. The sole method of doing it was by the reaction of creating heat and melting the stuff so that it would—

The Court:

Why wouldn't it get cold and go back and do the harm all over again? A. It would. And, he provides for that by

putting some benzine in afterwards. That keeps the melted paraffin in solution.

The next patent is dated 1896 issued to John W. Van Dyke on an application dated 1895, No. 556,651. The Van Dyke patent relates to a method of increasing the flow of oil wells in limestone formations and that is accomplished by the introduction of sulphuric acid into the well through a special pipe, the acid being then forced into the producing formation where it reacts chemically on rock, producing other material which is removed by subsequently washing out the hole in the formation.

The Court:

This is the first one that does—that attempts to do what our patent in suit does, namely, eating the rock? A. That is correct. It eats the rock in which the oil is coming to the well; it eats the oil bearing rock.

Q. What does that patent state about the means of getting the acid down into the well? A. Well, the patent specification states the following: (reading) "The following is a description of what is considered the best mode of carrying out the invention, reference being had to the accompanying drawings which form part of this specification, and in which—

"Figure 1 is a diagram of a well with the supply or reagent introducing pipe in place.

"Figure 2 is a detail view illustrating a mode of protecting the said pipe; the pipe A is provided with a rubber packer B in the rock above the Trenton limestone C in which the well is. It may be enameled or lead lined pipe, externally coated with enamel or lead below the packer B, or it may be otherwise made proof against corrosion. There is a box D provided with a funnel-shaped bottom to feed the acid to the pipe A. As shown in Figure 2, the pipe A is lined with a tube 2, of soft rubber, and covered exteriorly with another soft rubber tube 3, the lower end of the inner tube being turned back over the pipe A, and also the outer tube, and the whole wrapped to prevent ingress of liquid at the joint."

The Court:

Isn't everybody agreed that that patent that he has just referred to of 1896 is, so far as eating the rock is concerned, exactly like the patent in suit? He had that idea just as completely as the patent in suit, but when it came to preventing the misfortune of that acid destroying or eating the iron of the tools of the well, destroying those, he had an entirely different scheme of matter, isn't that true? Is there anything wrong with either one of those statements, that one is exactly alike, and the other is entirely different?

Mr. Owen:

The only addition I would make to your statement is that in this particular patent, sulphuric acid is used instead of hydrochloric acid. The next patent used hydrochloric acid, or is supposed to, but at the same time I want to call Your Honor's attention to the fact that although the action of the hydrochloric acid is the same when it gets into the formation, it is now known to be the same when it gets into the formation whether it is uninhibited or inhibited acid, it was not known at that time, and it was not known at any time prior to Grebe and Sanford patent that an inhibitor could be used which would not in some way affect the action of the acid when it got down into the oil well.

The Court:

Well, I thought that covered my second proposition, that it was entirely different as to how he was going to—he didn't have the idea at all, I thought, of actually protecting the tools.

Mr. Wiles:

That is right.

By Mr. Owen:

Q. Now, take up the next patent and explain that. A. The next patent which issued actually concurrently with the prior numbered patent to Van Dyke is that numbered 556,669 to Herman Frasch who assigned one-half to John W. Van Dyke. Van Dyke also assigned one-half of his to Herman Frasch. And the drawings are signed by Charles J. Hedrick in both instances.

Q. And, isn't it a fact that the drawings are the same in both instances, and that the specifications are almost word for word in both instances except the Van Dyke refers to the use of sulphuric acid and the Frasch patent refers to the use of hydrochloric acid? A. That is what I gather from the reading of both these specifications. There are differences in statement as to the chemical effects produced by the two acids, of course, because in the Frasch patent the reaction of acid on the rock is to produce a calcium chloride solution out of the rock, whereas the action of the Van Dyke patent employing sulphuric acid is to convert the solid limestone into a suspension of calcium sulphate which can not be forced out of the rock pores.

By Mr. Owen:

Q. Now, will you take up the next patent on that list? A. There is some of the Frasch specification, perhaps, that differs from the other that might be included. It states that after a rest of, say, twelve hours, milk of lime is pumped down to neutralize any trace of acid that might exist. The well is then cleaned out and the tubing replaced.

The Court:

That was to check further eating. They had the danger that might come if it kept on eating and ate out into the brine, I suppose? A. I presume that is so.

The Court:

Does Frasch also describe protecting his metal in the same way? A. The description of that is practically identical with that in the Van Dyke patent, the means of protection being to employ an enameled, lead-lined or rubber-covered pipe.

The Court:

Aren't there any acids except sulphuric and hydrochloric acid that will do the trick? Aren't there some other acids? A. Yes. There are many acids which will form solutions with calcium carbonate. There are a great many that will do that. But, as to how many acids there are which will dissolve oil producing rock is something I am not prepared to answer.

The next patent reference on the B side of the chart is a patent to George L. Ball, numbered 670,577, dated 1901, the application being filed in 1900. He makes a disclosure of introducing an acid into a well, and an alkali to react and produce heat. It is similar to Looney. However, this patent discloses also that in order to put the acid in you may employ a dump bailer. The patent states:

"The chemicals may be introduced into the well by dropping or pouring them therein and, as they are heavier than the oil, they sink to the bottom of the well, so that the heat is generated in the cavity where it is required; but the chemicals, or at least the acids, may be put in an ordinary bailer, and lowered into the well and then dumped."

By Mr. Owen:

Q. Will you explain the operation of these dump bailers to which the patent refers? A. I am not well advised in dump bailers. However, it is my understanding that it consists of a length of pipe of such diameter as will enter the well and be capable of being lowered to the bottom, and at the lower extremity of the pipe there is some sort of valve means whereby the contents of the pipe may be emptied when the lower end of it strikes the bottom of the well, by a kind of a trip arrangement.

Mr. Lyon:

It is just a bucket that you can drop on the bottom of the well and it will then empty its contents.

A. (Witness continuing): On the chart there is next shown a 1923 reference of Mills. It is a Bureau of Mines report of investigations, Serial Number 2550, to which Mr. Lewis has made reference in his testimony. It is Exhibit 8. There is a portion of that report that refers to the use of an acid in a well, and my recollection of what I heard from Mr. Lewis is that that portion of this reference has already been read into the record. On page 9 the use of hydrochloric and sulphuric acid both are mentioned. It describes what we have been finding heretofore in the patents, and in addition this bulletin of the Bureau of Mines also makes this statement with regard to sulphuric acid:

"Sulphuric acid should not be used in oil wells because of the danger of plugging the sands with precipitated sulphate salts, more especially calcium and barium sulphate."

The next reference is patent 1,410,827 issued to William F. Muehl, dated 1922, on an application filed 1920. It is for a method of cleaning oil wells. For that method he states that he uses acid. He introduces a suitable acid, such as hydrochloric acid, which will attack calcium silicate and other accumulations, to clean a well—

The Court (interrupting):

It's the same chemical action we have been talking about but he doesn't seem to be thinking about its going out inland but, more, he thinks this lime from the rock is going to get down in there and into the well proper and he wants to eat that out.

Witness continuing:

That is true. The use of the acid is more local than in the Frasch or the Van Dyke patents.

The Court:

Does he say anything about how he does that? A. Yes, he does. In fact, his specification includes a drawing of an apparatus showing a means for getting the acid to the location where he wants it to work, and it consists of a dump bailer similar to the one previously described, but for the valve in the lower end of the bailer he has provided zinc closures, a form of zinc disk. And these, of course, are dissolved by the acid, thereby emptying the bailer after a time. The discs last long enough to permit the acid to be lowered into the well.

Regarding the number of discs to be used, the patent states that these can be varied according to the length of time that the acid is to be allowed to remain in the bailer.

Quoting from the patent: "I prefer to use hydrochloric acid, which readily attacks zinc, and I prefer to have the zinc wafers or discs of such thickness that a given time will be required for the acid to eat through each disc. By way of example, each wafer may be designed to resist the acid for five minutes; therefore, if it requires five

minutes to lower the receptacle from the top of the well to the point of discharge, one disc will be placed in the bottom of the receptacle. If ten minutes are required, two discs will be used; fifteen minutes, three discs, and so on."

Mr. Lyon:

I call Your Honor's attention to the fact in that patent, page 2, line 22, the inventor says: "The particular advantage of providing the container is that the acid may be applied locally in the well, thereby reducing the quantity to a small portion of that which would be required if it were necessary to pour the acid from the top of the well." So the inventor was deliberately just putting down a bucketful of acid and calls attention to that is why he uses a bucket—because he doesn't want to use as much acid as would be involved pouring it down the pipe.

Witness continuing:

Another feature about that disclosure is that the size of the bucket which can be introduced is obviously small because he puts it down through the innermost tubing of the well.

As to whether there is anything to indicate the character of the formation in which this invention was intended to be used, I think the disclosure in the specification of the problem that this method was intended to solve indicates that the producing formation would probably be unaffected by the acid because the invention seems to be directed towards removing the accumulation of paraffin, calcite or acid-soluble deposits.

The Court:

And the amount of it indicates, as you say, a small amount, so he evidently wasn't thinking about getting out into the rock formation but getting some accumulation in his well.

Mr. Lyon:

Page 2, line 17, he refers to the lime or silicon or other accumulations on the side clogging the walls or screen will be relieved of the accumulation, and the oil from the surrounding stratum may flow into the well unimpeded. So I

don't see anything in here to say it isn't a limestone well, because he refers to lime. A. No, I found no reference to lime. It refers to calcium, silicon and other accumulation.
Mr. Lyon:

You don't find any reference to lime? I call your attention to line 17, page 2 of the patent. A. Yes. But that, of course, taken with the statement on the previous page, as to the deposits which are there, would seem to indicate that he is not talking about the structure of the producing formation.
Mr. Lyon:

How could there be any lime in that well along the walls if there was not lime in the formation into which the well was dug? A. There is no necessary connection between the existence of lime deposit in the sand well and the producing formation's composition.
Mr. Lyon:

Well, the lime must come from the formation in the well somewhere. A. That is an assumption.
Mr. Lyon:

What? A. That seems to be an assumption. There is no necessary connection between those facts.

The next patent is one issued to Lake and Phelps No. 1,498,045, dated June 30, 1924, on an application filed in 1923. His invention relates to a process of cleaning wells and apparatus therein, and it has for an object a provision of a novel process which readily removes colloidal muds, clays, etc., from the walls of the well hole or from any ap paratus or members within said well hole, and which muds would tend to clog or otherwise obstruct the flow of oil or gas through such apparatus or well hole.

Some acids chemically react with mud, or with clay, depending on the composition of the clay, but in this process according to the specification as I understand it, the way he states it at any rate, is that the acid solution seems to have greater affinity for the colloidal muds than it has for the metal casing through which the acid is introduced into the well hole. It would appear that the acid would re-

act quite readily with this mud, maybe far more, maybe so readily that it does so more actively than it does on the metallic part of the well.

Mr. Lyon:

Would you read that particular part to the court beginning at line 100, because here is a man that says this acid which includes hydrochloric, if handled properly in the pipe will not injure the pipe. A. I don't gather that from this specification.

Mr. Lyon:

Read beginning at line 100, will you please?

"It is found that the acid or acids used for these purposes will not appreciably attack the metallic structures in the well hole such as tubing and casing, collars, and the like, where mud is present in the hole, unless used to excess, inasmuch as when an approximate balance between the amount of acid and colloidal mud is maintained, the acid action will be expended upon the mud rather than in attacking the metal."

The next patent is Tilton, No. 1,608,869 issued in 1926, on an application filed in 1922, and renewed in 1925. He proposes to generate a heat in a well to melt paraffin using the action of concentrated sulphuric on water followed by a neutralizing sodium hydroxide.

The Court:

Now, what did he have that was new over Looney and somebody else? He had that idea of having a chemical reaction creating heat and melting paraffin. A. There is this possible novelty in it, there may be, of the use of a concentrated sulphuric acid, which, when added to water, liberates a large amount of heat, and then after that heat has been obtained he can get a further kind of heat by neutralizing the acid solution previously formed, using sodium hydroxide for the neutralization.

The Court:

Did he put them in separately? A. Yes.

By Mr. Owen:

Q. What did the patent state or show as to the meth-

ods used for lowering the acid into the well hole? A. It is my recollection that the container used for this was a lead-lined container. The patent states, beginning with line 89 of page 1: "The acid container proper is an elongated receptable, provided at its lower extremity with a valve discharge orifice 4. The valve for closing the discharge orifice 4 comprises a stem 5, extending through the orifice, and a head 6 lying within the receptacle. The head 6 of the valve comprises a conical lower portion 7 arranged to fit the wall of the container adjacent the discharge orifice 4, and an upper portion 8, which is shown as conical, but which may be of any desirable rounded or tapered form.

"Cooperating with the valve head 6 are a plurality of spheres 9 disposed within the container 1. When the container is lowered into operative position, the valve stem 5 comes into contact with the bottom of the well and moves upwardly within the container. When the valve head 6 moves upwardly, the spheres 9 run downwardly in the container and wedge between the conical portion 7 of the valve head and the corresponding inner surface of the container adjacent the discharge orifice 4. These spheres are of sufficient diameter to prevent them from passing out through the discharge orifice around the valve stem 5, and also to prevent their upward displacement around the valve stem and pass the valve head into the body of the container. If desired, however, the head portions 7 and 8 may be separated by the ridge or bead 10 shown in figure 6 of the drawings, to additionally insure against displacement of the spheres from between the lower portion 7 of the valve head and the inner surface of the container." When the stem 5 strikes the bottom of the well and raises the valve the acid, or whatever liquid is contained in the container,will flow out into the well hole.

The next patent on the chart is the patent to Leo Ranney, 1,806,499, issued in May, 1931, on an application filed in 1928 for a method of facilitating flow from wells. He states, "The invention is especially applicable to the cleaning of oil wells in which deposits of paraffin, calcite or the

like have obstructed the flow from the oil bearing formation."

Briefly he proposes to introduce into the well an acid and a gas-generating chemical which reacts with the acid to liberate the gas. Specifically, he puts in either hydrochloric or nitric or sulphuric acid or other acids or mixtures and then a charge of this gas-generating chemical, as an example specifically noted here is calcium carbide and that reacts with the acid solution making acetylene, and he also states that he may allow that acetylene to be ignited, thereby obtaining additional heat, that is, heat in addition to that produced by the reaction of the carbide on the acid. He does not state how he is going to get air to ignite.

The Court:

It wouldn't burn, would it, down there? A. I don't believe it would burn. Nevertheless, he would obtain the heat of the reaction of the carbide with the acid. He mentions that there will be parrafin in the well and this invention serves to remove those deposits. Acid and gas do not react as far as I know.

The Court:

I think he was doing probably what we have been reading about before where his acid reacted with whatever was in the well, various things in there would be likely to be something that would react with that acid, and in that way he might clean it out. A. Well, presumably he uses enough acid to obtain neutralization, although there is a statement on page 2 beginning with line 18 as follows: "Since the acid is neutralized or almost neutralized by reaction with the added chemicals or the calcite, etc., there is no substantial corrosion of the equipment." In other words he apparently does not use any more acid than is necessary to use up the gas-generating chemical he has put in, and the deposits of calcite, and so forth, that may be there.

Mr. Lyon:

If that is the last one of the patents on this phase of the chart that you intend to include, might I ask why you did not include patent 1,891,667 granted to Mr. Carr of

Pure Oil Company on an application which was a continuation of an application filed April 28, 1932? I am sure you are familiar with that patent and the application. The parent application is earlier than the patent in suit. Why didn't you include it in this Stream B, in Exhibit 10? A. That was not prior art to the Grebe and Sanford patent.

Mr. Lyon:

Do you know that of your own knowledge? It is an earlier filed application, and we have taken depositions here which will show the fact. Here is a patent of the Pure Oil Company that describes all about acidizing wells. The evidence in the depositions show that before Mr. Grebe made any invention at all, that Pure Oil Company came over with the idea to—

Mr. Owen:

I beg your pardon, that isn't true. That doesn't show that at all.

The Court:

Strictly speaking, application is not prior art.

Mr. Owen:

No.

Witness continuing: In making up Exhibit 9 I took this Carr application into consideration. In making up that line I also considered Bowman patent No. 1,809,546, dated 1931, but no others.

The Court:

Then there would be twelve. Then he has got this a little bit above, you see. A. Yes, sir, the 12th application to be filed was the Grebe-Sanford.

The Court:

There were 12 applications filed on which patents later or at some time were issued.

Mr. Owen:

There really would be 11, because this Mills is not a patent.

The Court:

Oh, yes.

Witness continuing: I want to make a correction be-

cause I had forgotten when I made that out as to the number that I had omitted the plaintiff's application. That one is out. So, there are ten, and the Grebe-Sanford patent in suit is the 11th application that was filed up to that time, on which patents at some time issued.

Mr. Lyon:

Well, which one of these kinks on Exhibit 9 represents the Carr application I have referred to? Is that on there at all? A. That comes after the Grebe-Sanford patent.

Mr. Lyon:

You just arbitrarily put it afterward. A. It is chronoligically subsequent to it.

The Court:

Which one? A. This Carr patent has a later number. It issued in December. The application was filed on the same day as Grebe and Sanford.

Mr. Lyon:

And it was a continuation of an earlier filed application, so it states. A. The application on which the Carr patent issued was filed June 30, 1932.

Mr. Lyon:

And this application states it is a continuation of a prior application filed April 28, 1932. A. No patent issued on that application.

The Court:

But, it is a continuation of it.

Mr. Lyon:

Yes. My point is if your chart is exactly as good as stated it was, according to my view the Carr application should come here and should affect this curve and change the curve.

The Court:

In other words, it would make this one a little steeper and this one not quite so steep.

Mr. Lyon:

It would also show that this upturn started with the Carr application instead of with the Grebe and Sanford. That is the significant part of it. But, I am willing to just

have the record show for the present that this curve does not correspond to the curve as it would be if the Carr application was in there ahead of the Grebe application.

By Mr. Owen:

Q. Will you explain what patents issued between 1920 and 1932 which caused the rise in this line on Exhibit 9, and state what those particular patents relate to, that is, just briefly? A. I cannot state the cause which brought on the issuance of these additional patents in that period of time.

The Court:

Well, here is one thing that I see (indicating on the chart): We had just nicely got through with the war and the boom period came on. I do not know whether that means anything in the oil industry, or not.

Mr. Lyon:

It meant a whole lot to the oil industry.

The Court:

You see this upturn here about the time that we got through with the war in 1918, or it may be a little past that.

Witness continuing:

From the point about 1922, where the curve starts to go up, to where it flattens out in 1930 or 1931, very few patents are in consideration in that space. In 1922 the patent issued to Muehl, and that was the sixth application. That is the one at the angle here, right above or just past the 20 mark. The next one was Lake and Phelps, issued in 1924. That is the next point right here (indicating). The next to the right of that, and up a little, is the issuance of Tilton in about 1926. Then the next hump in 1928 is the issuance of the Ranney patent. Then the next is going off to the right, Bowman, 1931. The Muehl patent was dumping acid into a well with a dump bailer to clean out paraffin and calcite deposits and such like. The Lake, et al., patent was for breaking up mud colloids in the well hole. Tilton was for melting out paraffin deposits. Ranney was for melting out paraffin deposits, and Bowman was

for cleaning the well liner. That had not been mentioned previously.

The Court:

Here's the way I understand this graph has been made. Here he starts with the first patent down here (indicating 1865), the next patent he made a date for that, the next patent, and so on; moving up according to the number, getting at the place in the elevation, representing the number of patents, and the date of the application would fix its date for right and left. And then having fixed all those marks, he just hitched them all together. Isn't that the way you made it? A. Yes, sir.

Mr. Lyon:

Yes, but I don't understand this flat one which apparently separates this portion of the curve from that. It seems to me according to the witness' prior testimony there was another additional application between this point (indicating) and this, and necessarily this curve shouldn't show that break, which, in my opinion, unduly emphasizes something that does not exist.

The Court:

What I am going to do right now, instead of spending a lot of time about it, is to ask that they hand you their book of patents and you make one of those graphs.

Mr. Owen:

I am perfectly willing to do that, and have Mr. Rebbeck make his curve.

The Court:

I like things of that kind. There is that continuity. They might easily make a mistake in that.

Mr. Owen:

At the time of the adjournment last evening, Your Honor, we had been discussing the correctness of the chart, Exhibit 9, and I asked Mr. Rebbeck to make a new chart showing where each patent enters the picture, and we have that here, and I would like to have him explain it to you.

The Court:

We will call that Plaintiff's Exhibit 9½.

(The chart was thereupon marked PX-9½.)

The Witness:

This chart, Exhibit 9½, contains the same information that was on the chart we had yesterday, Exhibit 9, with the exception that the curve representing the information is now drawn in a stepwise manner, to bring out the fact that in each of the periods of time involved where there is no change in the number of applications that issued into patents the line of the curve is horizontal. Beginning at the left-hand side of the chart, in the year 1886, the first patent involving the use of an acid in a well was issued, and is shown by this rise here to the level of the first step. Then from that time until about 1872, there were no more applications filed on which patents issued. In that year another one issued, carrying the level up to here (indicating). Then no more applications were filed on which patents issued until 1895, when there were two filed that became patents. That raises the level up to here (indicating). Then from 1895 to 1900, no more were filed until we get to 1900, and then there was a new one filed. That brings the level up to here (indicating). That makes a total of five in those thirty-five years. And then from 1900 to 1920 no application was filed for which we have discovered an issued U. S. patent. Thereupon one more was filed, bringing the number up to 6, and then in about 1922 another one was filed making 7, and then in 1923 or '4, another one was filed making 8. I have put the Carr application in when the continuation was filed and not when the original was filed.

The Court:

You put it in when the continued application was filed, and not when the original one was filed? A. That is correct.

The Court:

If it was put in with the original application, it would come in just over the line somewhere? A. It would come in in 1932, April 28. It would have made this kick up here a little higher, perhaps. It would have made three in here instead of two, as we have it now.

By Mr. Owen:

Q. In other words, if the original Carr application were included it would make this first vertical line to the right of the year indicated by the line 30 a little higher than it is now; is that right? A. Yes, that is right. Now, from 1929 until 1932 there weren't any applications filed on which a patent issued excluding the original of the Carr continuation which is included in this jump. The continuation is included in here and the Grebe-Sanford patent is not included inasmuch as that is one of plaintiff's, but this kick here is due to the filing of the Carr patent, 1,891,667, and a Carr-Humphrey application which issued in 1935, I believe, and I don't recall the number of it. This vertical line at the right of the line indicating the year 1930 includes the Carr continuing application which we have been considering. Even if it was with reference to the original application it would come in the same space. It would just raise this kick up, this step. This little tiny step here would be one notch higher.

The Court:

Now, as he says, as you get higher up you would arrive at the same point all the way up. It just depends whether you cross that road over to the vertical line one notch sooner or not.

By Mr. Owen:

Q. Now, will you continue from the point you left off and state the number of applications indicated in each year by each vertical line? A. Reading from the graph, the first break above the date corresponding to the filing of the Grebe-Sanford represents two more applications on which patents issued, making 12. This step indicates 15 at some date here, I think 1934. The next step indicates about 23 or 22 applications on which patents issued, up to the year 1935. And 25 applications up to 1936. Then we go to that step up here indicating a total of 40. That means there are 28—or there is 30 more than at this time here. And this point is 47, indicating 37 more. And this is 54 indicating 44 more. And that is 56 indicating 46 ap-

plications filed up to this year 1939 on which patents issued involving the use of acid in an oil well.

Q. Referring now to Exhibit 10, please take up the patents indicated under Stream A on the left side of the chart and explain what they disclose. A. On the left-hand side of the chart there have been listed a number of references composed of patents and publications in which some knowledge is given of the use of inhibiting agents to reduce the corrosiveness of acids on iron or steel. The first entry on the list is dated 1845 and is an article appearing in the French publication, Comptes Rendus, by Millon, in which he reports numerous tests made of the corrosiveness of some acid solutions and the effect of the presence in that acid solution of small amounts of metals in the electromotive series on the corrosive action of the acid. This journal apparently has been in publication for many years. I have seen a complete set of them. We have such a set in the Dow Chemical Company's Midland library. I have also seen sets of this journal in other technical libraries, and it is my understanding that it is widely disseminated in the libraries of the world where scientific and other information is kept. I would like to quote a few parts of the translation of this article:

"The impairment of metals either by pure water or by water charged with acid or saline principles is a phenomenon that occurs frequently in the laboratory. This phenomenon also concerns our domestic uses and among industrial facts it certainly has an important place."

The next paragraph goes on to state:

"The experiments that I am about to describe are all connected with this impairment of metals by water in the presence of acids or salts. They only comprise in a word a simple indication of some circumstances under whose action the common metals, iron, zinc, tin, copper are attacked and sometimes preserved but among all these circumstances there is one that I shall point out at once because I think its intervention has been almost unnoticed heretofore. I wish to call attention to the influence of small quantities."

"This influence, if I do not mistake the first impression that I have received, is considerable. If one should say, indeed, that a little quantity of metallic solution, added in the proportion of one thousandth, of one hundred-thousandth, and often in a smaller proportion, was sufficient to increase hundred-fold the action of an acid on a metal, or to annihilate this action, or to provoke it when it did not exist, or finally even to change the nature of the products to such a point that hydrogen replaces nitrous compounds, one would seem to be, in such an assertion, as far from the facts as from chemical predictions.

"Nevertheless, that is what happens."

Those are his introductory remarks, and then he goes on to describe some of these experiments. The method of his experiments, I think, is summarized in this paragraph which I will now quote from page 2 of the translation:

"Thus, rolled zinc has been brought into the presence of dilute sulphuric acid to which has been added some traces either of platinous chloride, or of tartar emetic, arsenious acid, copper sulfate, silver sulfate, etc. The metal, weighed before the reaction, was weighed again after the reaction had lasted for a definite time. In other instances, the gas was collected and measured. I shall indicate the principal conditions of the experiments made by means of zinc and dilute sulphuric acid. The zinc was rolled in sheets thin enough to give 100 to 102 centimeters of surface per weight of 15 grams. The sulphuric acid was composed of one part of monohydrated sulphuric acid SO_3H_2O to 12 parts of distilled water. The zinc was weighed exactly, and six nearly equal quantities of water were introduced into six glass flasks, each of which contained 1½ decilitres of the one-to-twelve sulphuric acid."

The flasks were distinguished by the numbers 1, 2, 3, 4, 5 and 6. Now, I will pass over these experiments on zinc and go to those he performed on iron, inasmuch as we are here interested in iron. Here we have the essentials of his method. He weighs a zinc piece or metal piece and puts it in the acid for a given length of time, withdraws it,

weighs again, and determines by the loss in weight what has happened. Now, the experiments on iron and tin are referred to on page 11 of the translation:

"Iron and tin have been subjected to tests analogous to those of zinc. One-to-twelve sulfuric acid dissolves iron turnings rather rapidly; some drops of platinous chloride communicate an extreme intensity to this action. Arsenious acid, on the contrary, stops all action on iron by sulfuric acid; this influence is sufficiently pronounced for the metallic iron to keep for a whole month, and without doubt still longer, in one-to-twelve sulfuric acid which dissolves it rather rapidly. When the iron is well cleaned, some drops of an aqueous solution of arsenious acid are sufficient to preserve it from the acid; at the same time it preserves metallic reflection whose shade becomes only rather darkened. Tartar emetic slackens the action of sulfuric acid on iron, but does not stop it. Mercurous chloride acts like tartar emetic. Copper sulfate accelerates strongly the evolution of hydrogen; silver sulfate also accelerates it, but less appreciably."

By accelerating the evolution of hydrogen it means that the iron test piece is dissolving at an accelerated rate.

"Hydrochloric acid receives, from small quantities of metals, the same influence as dilute sulfuric acid: these reactions can even be observed with rather concentrated hydrochloric acid; it is sufficient to dilute the pure fuming acid with 2 or 3 volumes of water. In some cases the addition of a small quantity of copper sulfate has suspended very appreciably the action of hydrochloric acid. The iron becomes covered with metallic copper and remains for several hours without furnishing hydrogen; but it has not always been thus, without it being possible to ascertain whether this difference depended on the hydrochloric acid or the iron."

These tests continue with some other acids. The next one mentioned is arsenious acid, and according to Millon arsenious acid stops all reactions as it did with the two preceding acids, the preceding being sulphuric and hydro-

chloric. It goes on to say :"Tartaric and racemic acids are identical in all the influences that they undergo; more abundant evolution with platinous chloride; hindrance to reaction with arsenious acid; almost complete indifference on the part of other metallic solutions." I believe that that gives the essence of this part of the article.

The next reference on the chart on the left-hand side is dated 1883 consisting of a U. S. patent No. 288,150 to Benjamin F. Aiken, Jr., for wire or metal cleaning bath. This, I believe, is one of the first U. S. patents to mention the addition to a corrosive acid of something to obviate its corrosive effects, those corrosive effects being the action of the acid on iron and steel. This patent is in the pickling art, which is briefly stated to be as follows in the patent specification, page 1, column 1:

"In the successive processes of drawing wire the iron becomes fibrous and requires to be annealed to render it ductile and in the operation of annealing its surface becomes more or less covered with an oxide scale which must be removed before the operation of drawing can be continued. This is commonly done by immersing the wire in a hot bath of dilute sulfuric acid for a short time and then checking the action of the acid upon the metal or devitrolizing it by immersing the wire in a bath of hot water or subjecting it to a current of cold water, otherwise the excessive action of the acid bath would render the wire brittle and unfit to be drawn. The wire or wire rods are then coated or covered with a paste of meal or flour, clay or a solution of salt, or of lime, or of a salt and lime, either alone or in connection with oily and fatty substances which act as lubricants to the surface of the wire as it passes through the die plates."

Now, coming to his invention, he says: "I use instead of the bath of dilute sulfuric acid above mentioned a bath formed by adding to water a cleaning corrosive acid. In case the wire is to be drawn I use sulfuric acid; in other cases such as when coating with zinc or tin, hydrochloric or nitro-muriatic acid may be used and to the acid and

water I add cyanogen generally, and for convenience in the form of a metallic cyanide."

Now he goes on to say what he gains by doing that as follows: "By the combination with an acid cleaning bath of cyanogen in the form of a soluble metallic cyanide I increase the efficiency of the acid bath and effect a great saving in the cost of cleaning. I also obviate to a considerable extent the injurious results of the excessive action of the sulfuric acid bath in rendering the iron brittle arising either from the absorption of free hydrogen or from other causes."

The Court:

Is that a very good description of an inhibitant? A. Yes. For the reason that the inhibitants that we find in these patents out of the pickling art are used to correct this hydrogen embrittlement which would otherwise occur if an inhibitant was not used.

Mr. Lyon:

I would just like to have the court have in mind that this is a selection of patents which the defendant in this case has not selected, and it is a different selection from what was before the court in the Williams Brothers case.

Mr. Owen:

I want to make it clear that the purpose of this chart was not to make a complete disclosure of the prior art. We couldn't do it on a chart of this kind. But we merely selected illustrative patents or publications which would show the developments.

Witness continuing:

Now, the next one on the chart, left-hand side, is dated 1901, and is a publication called The Journal of the Society of Chemical Industry in which there appears an article by James T. Conroy on page 316, entitled "The Rate of Dissolution of Iron in Hydrochloric Acid." This article opens with this paragraph:

"The behavior of acids towards metals is a problem of great interest both to the chemist and the manufacturer and such behavior has been the subject of considerable investigation.

"Sometimes, perhaps most frequently, it is the manufacturer's object to obtain a metal not acted upon by some particular acid. At other times, action is desired, and in this case a knowledge of the course of the reaction, its rate and the conditions under which it occurs is of the greatest importance.

"To take a particular instance, I may refer to the cleaning of iron by acids, the so-called pickling process, a preliminary operation in the preparation of this metal for the galvanizing bath."

This article goes on with experiments performed on the rate of dissolution of iron in hydrochloric acid at different temperatures and with different concentrations of acid, hydrochloric acid being capable of many concentrations. Then when we come towards the end, in fact it is the end, he refers to the fact that the foregoing experiments were all done with distilled hydrochloric acid, practically free from impurity of any kind. (Reading):

"In practice commercially pure acid is employed. Such acid must be free from arsenic, the presence of which is prejudicial during the pickling stage apart from the trouble it causes later on in the galvanizing bath. The effect produced when arsenic is present in small quantities is shown in Table 4. When larger quantities are present the iron becomes completely covered with a film of arsenic which at ordinary temperature almost completely checks further action even with the more concentrated acids."

Now, by referring to this table, we see that the experiments were performed with hydrochloric acid of concentrations between 180 and 216 grams per liter, and with amounts of arsenious oxide of from 0.04 grams to 0.16 grams per liter and at temperatures from 18 to 61.5° C. In this experiment he measured the cubic centimeters of hydrogen evolved per hour both before arsenic had been added and after arsenic had been added, and he sets down the rate of evolution figures thus observed. To take one example out of the list, the one that appears on the chart, and converting the concentration given here in grams

per liter into weight per cent we get the following figures:

Two hundred grams per liter of hydrochloric acid is approximately a 20 per cent hydrochloric acid solution. The addition of .16 grams per liter of arsenic trioxide is approximately a 0.015 per cent solution of arsenic, and the rate of hydrogen evolution without the arsenic is given here as 26 cubic centimeters per hour, and when the arsenic is present the rate drops to 19 cubic centimeters per hour or a reduction in the rate of evolution, computed by me to be about 27 per cent.

The next one is dated 1912, an article by Oliver P. Watts, which appeared in the Transactions of the American Electrochemical Society, Volume 21, beginning on page 337, entitled, "The Effect of Various Substances on the Rate of Corrosion of Iron by Sulphuric Acid." The title is a little bit misleading, because he also works with hydrochloric. His opening paragraph is as follows: "In volume 8 of the transactions of this society C. F. Burgess called attention to the remarkable reduction in the corrosion of iron by sulphuric acid brought about by the addition of a small amount of arsenious oxide to the acid." Later he explained the protective action as follows:

"The explanation which has been offered for this phenomenon is that the iron receives by contact with the solution an extremely thin coat of arsenic which resists the action of the acid and protects the underlying metals."

He also gave experimental proof that the iron was coated with arsenic. The second paragraph states:

"It has long been known that by dipping clean iron into solutions of suitable composition and concentration thin coatings of gold, silver, platinum, copper and several other metals may be deposited on the iron. It is generally conceded that such coatings are not sufficiently continuous and impervious to protect the underlying metal from corrosion, even though the metal forming the coating may itself be thoroughly resistant to the corrosive agent. Instead of being a protection, such coatings are usually considered to be stimulators of corrosion."

We started at the place where we had an acid solution containing arsenic in the solution as arsenious chloride, presumably. There is no metallic arsenic in this solution at all. The element is there but it is not present as little bits of metallic arsenic that you could fish out. It is dissolved.

Now, this third paragraph goes on to discuss the theory of this protective action as follows: "Since all metals which thus deposit upon iron when it is immersed in a solution of the metallic salt are electro-negative to iron, a short-circuited voltaic cell is formed, of which the iron is anode and the metal deposit is the cathode. So long as any iron remains in contact with the electrolyte, it would seem, except for certain considerations which will be presented later, that the corrosion of the iron ought to be stimulated by this condition, and that the only way in which such a coating could afford good protection would be by covering the iron completely, so that no electrolyte could come in contact with it.

"Speaking of the effect of other metals in contact with iron, W. H. Walker says: 'Tin is a metal which, like copper, accelerates the corrosion of iron by aiding in the oxidation of the hydrogen set free by the reaction.' M. P. Wood calls attention to the injurious action of metals, 'The use of anti-corrosive, or anti-fouling paints, containing salts of any metal, is attended with the greatest danger to the coated (iron or steel) structure. These pigments are extremely sensitive to the presence of saline elements in moisture, their action being to rapidly dissolve portions of the iron, and to deposit the metal which they contain upon the surface of the plates, and these deposits, exciting energetic galvanic action, cause corrosion and pitting to go on with alarming rapidity. Both mercury and copper salts are offenders in this way.' "

I am going to read directly from paragraph 2 on page 338. (Reading): "It appears then, that arsenic is unique among the metals which precipitate themselves upon iron from solution, for arsenic protects iron almost completely

from powerful corrosive agents, while the other metals are generally considered to aggravate corrosion and rusting.

"If the coating of arsenic is so porous and imperfect as the action of acids show the coating of copper, for example, to be, how can the arsenic protect the iron any better than copper does? It occurred to the writer that the explanation lay in a high over-voltage or excess potential of hydrogen on arsenic, and the experiments which follow were undertaken to discover whether this is the explanation of the singular and mysterious protective action of arsenic. If the above explanation is correct, among the metals which deposit upon iron when it is immersed in a solution of their salts those having a high over-voltage for hydrogen should protect iron, and those of very low over-voltage should aggravate the corrosion."

The Court:

Does that mean that silver and copper, and those other things that he mentions actually tend to corrode, destroy iron when they are present, worse than if they are not present? A. Yes.

The article goes into the matter of the electrode potentials of the metals involved here, that is the voltage assumed by the metal with respect to the solution in which it is immersed, and he gives a table of what is called single potentials of many of the metals in the electromotive force series of metals between iron and mercury, and including those metals. Then he goes on with his theory as follows:

"On the theory that the protection of iron by a deposit of arsenic is due to the high overvoltage of hydrogen on the latter, the action would be as follows: Iron dissolves and by so doing deposits arsenic upon the surface of the iron. Since the arsenic is deposited simultaneously with the dissolving of the iron and only as a result of this dissolving it is hardly possible that the iron should be completely covered by arsenic, but here and there holes will exist allowing the iron to make contact with the electrolyte. Voltaic cells are thus formed."

The Court:

Is this chap right in his theory? A. I subscribe to this theory. (Continuing reading): "The iron is anode and the arsenic cathode, and just as in any other primary cell with sulfuric acid as electrolyte, hydrogen is deposited on the cathode, but when hydrogen is liberated on arsenic the potential of the latter is raised 0.39 volts higher than 0.277, the potential at which hydrogen is liberated on platinum black. This would raise the potential of the arsenic to +0.113 volts or higher than the potential of the iron anode. This means that in our iron-arsenic cell there can be no visible evolution of hydrogen on the arsenic for before this can occur the potential of the cathode has become equal to that of the anode and corrosion of the iron ceases. In other words, this particular primary cell polarizes so badly that after a few seconds of action its electromotive force has fallen to zero."

Then he goes on to say (reading): "If the above explanation is correct, protection should be afforded by those metals which plate out on iron by immersion, and whose over-voltage for hydrogen is great enough to raise their potentials to at least equal the single potential of iron. The potentials of the following metals are far enough below that of iron to expect that they will deposit on iron even in moderately strong sulphuric acid."

By Mr. Owen:

Q. In this Watts article, I notice that on page 352 he gives a table under several headings: One of them is "Retarders of Corrosion," and another on page 352 is "Accelerators of Corrosion." Now, I would like to have you state to the court which metals are contained under each of these headings, first under the heading of "Retarders of Corrosion." A. The first here is arsenate of sodium. Of course, that is not a metal but it is a compound containing the metal which he used. Arsenic sulphate, chloride of manganese, chloride of mercury, chloride of sodium, chloride of tin, chrome alum, chromium sulphate, mercuric chloride, mercuric sulphate, and stannate of sodium. Stannate of sodium is a tin compound.

Under the heading "Accelerators of Corrosion" the first in order is bismuth sulphate. Then chromium chloride, copper sulphate, gold chloride, mercurous nitrate, platinum chloride, potassium chlorate, chromate, dichromate, nitrate, permanganate.

The next reference on the chart, Exhibit 10, is a publication from the Bureau of Mines, Department of the Interior, dated October, 1919, entitled "Substitution of Nitre Cake for Sulphuric Acid in Pickling Steel," by E. E. Corbett, Chemical Engineer, U. S. Bureau of Mines.

On page 2, under the heading of "Mechanism of Pickling Reactions," it states (reading): "The free acid in hot, dilute solution attacks the metal very readily, etching it away from beneath the coating of scale and consequently throwing off the particles of oxide from the surface. Iron goes into solution as ferrous sulphate; and the hydrogen which is liberated at the face of the metal is carried rapidly to the surface of the solution, where it escapes into the air with the steam and other gases rising from the pickling bath. * * *"

Now, the portion of this publication which is of interest in this connection here is that part beginning on page 5 under the heading of: "Inhibition, or moderation of metal attack," as follows:

"The activity of the acid, then, is directed to attacking selectively and dissolving the sound metal rather than the more resistant oxide or scale; but in well regulated pickling practice the selective attack is limited, and, indeed, materially re-directed and controlled by the use of bodies of a colloidal or semi-colloidal nature whose influence serves to protect the metal during scale removal. These bodies are for the most part of vegetable origin, and comprise various wood sugars and gums, and cereal starches and intermediates occurring in commercial grain milling."

And then he goes on to mention other types of inhibiting agents as follows: "Tin and copper salts are representatives of the inorganic type of semi-colloidal inhibitors; but their action is of inferior consequence and their use re-

stricted because of the cost of adding to the bath quantities sufficiently large to exercise a sensible influence, as well as their tendency, undesirable for most purposes, to plate out from solution upon the metallic surface."

Mr. Lyon:

I would like to ask a question before we leave this Corbett article. Was this article ever published? If so, where, or from where, by whom, and when? A. I can refer to an article which appeared subsequently to this as a result of the issuance of this article by Mr. Corbett in the Automotive Industries for 1918, December 5. This article was almost re-written word for word in that publication, which, of course, has wide circulation in the metal trades.

The next reference under Stream A of Exhibit 10 is dated 1921. It is the British patent No. 158,768, having a complete accepted date of February 17, 1921, for improvements in pickling iron or steel. This patent is apparently the counterpart, or the British application corresponding in many particulars to one filed in this country in the name of Vogel, so I have put the name Vogel against this British patent. This teaches about the corrosive action of the acid during the pickling operation, and some of the evil effects resulting from that, and proposes the addition to the pickling bath of certain substances to overcome those difficulties.

Quoting from the specification, page 2, column 2, beginning with line 73, it reads as follows:

"A modification of the process consists in adding to the pickling liquor, not the protective substance itself but a suitable extract thereof. It has been found that it is not the main constituent of the substance in question, namely, anthracene, naphthalene, phenol or the like, that has a particularly good effect, but other constituents the chemical constitution of which has not been elucidated, but which nearly always accompany the main constituent. The active substance may be extracted by inorganic acids, neutral or acid salts, organic solvents such as hydrocarbons (petroleum, tar oil). Advantageously the parent substance may

be treated with 3 to 4 parts of sulphuric acid of strength which may vary, or of hydrochloric acid or of other suitable extracting agent and, according to its strength, 1 to 10 per cent of the extract may be added to the pickling liquor.

"There is added to the liquor a quite small proportion of a material which causes formation of the thin protective layer. For forming such a layer, having regard to sufficiency of supply and cost, the following has been proved particularly suitable additions:—Crude anthracene, sulphite lye, residues from the production of naphthalene and the like."

There are some other substances mentioned which might be used. "There may also be used either alone or in addition to the said parent substance the waste acid from the refining of mineral oil, ground coal tar oil, coal tar oil, paraffin wax, and the like, or acid resins, or distillation residues of organic compounds of any kind, particularly residues in which pyrogenis decomposition has occurred." By Mr. Owen:

Q. In this British patent, is mention made of any particular acid in which these inhibiting substances may be used in connection with the pickling bath? A. There is the mention of a dilute mineral acid, for instance hydrochloric acid of 22 Baume specific gravity used, or sulphuric acid of 10 to 12 Baume specific gravity, frequently mixed with a solution of sodium sulphate.

The last patent is dated 1928, No. 1,678,775, to James H. Gravell. This patent discloses the use of metals in an acid solution, the same metals that we have previously seen and which have been referred to in some of these prior articles, including the Watt article, for the purpose of putting a protective coating on iron and steel containers, so that the action of the acid on the containers would be prevented. And these metallic inhibitors may be used in that process with and without the presence of what are here called pickling control substances or acid regulators.

The acids which are supposed to be rendered non-corrosive by the presence of these added metallic elements are

any of those acids commonly or normally corrosive to iron or steel, and because of that corrosiveness would have to be carried in glass or specially lined containers.

Q. According to this patent, what metals are supposed to have that protective action? A. The patentee states that "The metals which have that property are below iron and above mercury in the electro-motive scale." Some of the common metals that lie in that range of the series are cadmium, nickel, lead, tin, arsenic, antimony, bismuth, thallium and copper.

CROSS EXAMINATION

By Mr. Lyon:

Q. In connection with the selection of those patents didn't anybody suggest or refer to the list of patents appearing at the bottom of page 496 of 81 Federal Reporter, Second Series, the particular patents that were referred to by Judge McDermott as showing inhibitors? A. I don't recall whether they looked at that or not.

Q. You didn't hear any discussion about whether you better put on this Stream A the same patents that Judge McDermott set forth in his opinion, or whether you better put different ones in? A. I do not recall anything like that. I am practically certain there was no mention of that.

Q. What is supposed to be represented here by the graphical illustration extending from Gravell's patent in 1928 down to this block in which appears the words "Grebe and Sanford"? That there are no patents between the Gravell patent and Grebe and Sanford's patent relating to the addition of inhibitors to hydrochloric acid? A. No, it doesn't mean that. I don't recall what ones intervene in that period. I don't remember how many there were in that thing. It seems to me there were quite a number of patents in this art of pickling and its related arts, but their pertinency—it doesn't add anything to these things that are already there such as there were where,—I believe they were left off for that reason.

In my search of the prior art and the investigation that I made of patents and the literature references prior to the Gravell patent, I found reference to shipping hydrochloric acid in a steel container or drum, protecting the drum or container by the use of an inhibitor. Those references are not on this chart. These are simply in connection with the prior state of the art for Grebe and Sanford.

There is a reference by an author named Fawcett in the Journal of the Society of Chemical Industry of London in which he discloses the use of arsenic to be added to sulphuric acid and for the shipping of that acid in an iron drum so that the drum would not be attacked. This article is entitled "Action of Concentrated Sulphuric Acid on Iron."

Q. Did you find anything in this Fawcett article that refers to shipping hydrochloric acid in steel containers? A. I don't believe there is mention of that.

Q. Well, now, have you found any other, is there any reference that you have found that you have omitted from Stream A prior to the Gravell patent which suggests shipping hydrochloric acid in a steel container and protecting the container by an inhibitor? A. I believe there is another one. The patent to which I refer is No. 1,608,622, filed September 30, 1925, for process for preventing the dissolution of iron and steel in sulphuric acid and pickling baths.

Q. In connection with arranging your curve on Exhibit 9-A, we discussed the Carr patent. I hand you a certified copy of the file wrapper of the Carr patent as it issued, No. 1,891,667, and the parent application filed April 28, 1932. Have you ever read either the original application or the Carr application, upon which the Carr patent was issued? A. I may have, but I have forgotten now.

Mr. Lyon:

I would like to offer, Your Honor, so that we can have it for future discussion, these two certified file wrappers; the first being the file wrapper upon which the patent was issued, No. 1,891,667; and the second, the file wrapper of the earlier application.

The Court:

Let us call the first one that you marked DX-11, and the other will be DX-11½.

(The documents in question were thereupon marked Exhibits DX-11 and 11½.)

Q. Now, who made the decision in connection with what was to be incorporated on the curve of Exhibit 9-A, that this Carr patent should not go on the curve, or, should not go on until after you have indicated that the Grebe and Sanford invention had come into existence? A. I decided that.

Q. Who? A. I decided that.

Q. Did you discuss that with counsel for the plaintiff here, who are appearing in this case? A. Yes, I discussed that.

Q. On what basis did you make that decision? A. Let me see. The decision to put these patents on was based upon the filing dates, and I assumed that that would fairly represent the date of invention of these patents, in the absence of other knowledge on the subject.

Q. Then you did not actually go into the question, the factual question of which of these inventions was earlier? A. That is right. I am not advised as to that.

Q. You know, do you not, that the Dow Company, the plaintiff in this case, holds the rights under this Carr patent, and the invention of Mr. Carr? A. I do not know what you mean by that.

Q. You don't know what I mean by that? Don't you know that the Dow Company is licensed under this Carr patent and Carr invention? A. Yes; they have a license.

Q. You know that the Dow Company pays a $5.00 royalty for each and every acidizing job that it does to Pure Oil Company under these patents, do you not? A. That is what I have been told.

Q. Well, now, you did not go in to find out whether the Carr invention was ahead of the Grebe and Sanford invention? A. Not in constructing this chart, no.

Q. Did you have anything to do with the preparation

of the application upon which the Grebe and Sanford patent No. 1,877,504 was issued? A. No.

Q. That was not any—you did not have anything to do with that? A. No, I did not.

Q. You don't know whether or not as originally prepared that application prescribed that the use of inhibiting acid was unnecessary, or the use of an inhibitor in the acid was unnecessary? A. I had no part in the preparation of that application.

By Mr. Lyon:

Q. Referring now to this Exhibit 9-A, the curve, can you give us a list of the patents and other references that are embodied in this curve subsequent to the point on the curve to which the arrow refers, and with a statement as to what they are about? A. The Carr patent 1,891,867 filed June 30, 1932, was a method for facilitating the flow of wells and, briefly, it consists in loading the well hole with oil so as to confine the acid subsequently introduced to the lower levels of the well to prevent the acid from rising in the casing.

DeGroote, 1,922,154, filed January 9, 1933, proposes to emulsify acid in an encasement of oil before putting it in the well so that it won't corrode the pipe.

MacMillan, 1,969,230, filed February, 1933, loads the well with oil to force the acid into the producing formation.

Weir et al, 1,984,668, filed March 10, 1934, is for demudding the walls of the well hole with acid when the mud has previously been treated with calcium carbonate so it will have an acid soluble constituent in it.

Wilson, 1,990,969, filed March, 1933, is for acidizing an oil producing formation, the acid for the purpose being generated in situ by the reaction of a solution of hydrochloric acid and a soluble fluoride.

Ambrose et al., 1,999,146, filed June, 1934, for a method of increasing the production of wells proposes to employ chlorine gas in the well hole, the gas reacting with water therein to generate an acid.

Mills, 2,001,350, filed 1934, proposes to introduce into

the well and into the producing formation in succession alkali, then an oil spacer, then acid, and repeating that over and over, thereby forcing out into the surrounding formation concentric rings of acid and alkali which eventually mingle with each other and generate heat in the formation, or otherwise do something there.

Muscatt 2,010,409, filed 1934, is for producing a plugging deposit in water-bearing formations, which might be adjacent to the oil producing formation or even in the same formation, and he reacts therein sulphurous acid and hydrogen sulphide, thereby getting a precipitate of sulphur in the pores.

Carr, et al., 2,018,199, filed October, 1932, is for balanced pressure method for introducing acid reagents into oil wells and it consists in introducing inhibited acid, that is, acid containing arsenic acid, into the oil well after it has been allowed to fill with the produced fluid of the well.

Muscatt, 2,016,118, filed 1935, is for method of selective shutting off of water flow in oil wells, and consists in injecting sulphur mono-chloride into the well under heavy pressure so that it enters and passes outward through the pores of the wet formations, the sulphur mono-chloride hydrolyzes in the earth formation, thereby depositing free sulphur, and, of course, along with that reaction there is produced hydrochloric acid.

Woods, 2,030,777, copy of which I do not have here, is about drilling a well in an acid-soluble formation with conventional rotary tools, and in place of circulating drilling mud through the tools while the drill is in operation, he would use hydrochloric acid.

Pitzer, 2,035,719, filed in 1935, is for method of treating oil and gas wells and he proposes to introduce into the cavity at the base of the well what he calls an inert crushed treatment material of a particular size or mesh, namely 1 to 1½" mesh, and he may thereupon treat the well with acid or alkalis or other chemicals.

DeGroote, 2,038,720, filed 1936, is for process for increasing productivity of wells and it consists in emulsify-

ing two different reagents, introducing them into the well and allowing these emulsions to mingle and produce a reactive agent in the well, which is forced into the formation.

Parkhurst, 2,038,956, assigned to the Standard Oil Company, filed in 1934, is for the acid treatment of an oil well, the title being "Well Treating," and it consists in introducing the acid solution into the well and then a charge of an aqueous solution of caustic soda.

DeGroote, assigned to Tretolite Company "Process for Increasing the Productivity of Wells," No. 2,045,759, is similar to the other ones where he employs an emulsified acid for acid treating in the producing formation.

Davis, 2,045,899, filed April, 1935, is for method of increasing production from wells, and it discloses to use acetic acid for the purpose, the acid being injected into the producing formation.

Saukatis, filed 1934, 2,049,517, discloses to treat wells by introducing into them an inhibited acid solution, the inhibiting agent being a combination of copper and any one of dozens of organic chemicals which themselves have an inhibiting action.

DeGroote, 2,050,931, filed 1936, is for "Preliminary procedure for conditioning wells," after which he discloses that they may be treated with hydrochloric acid.

DeGroote, 2,050,932, filed in 1936, employs an emulsified acid solution for treating the well, there being present what he calls a dormant de-emulsifier so that this emulsion will not break too soon.

DeGroote, 2,050,933, filed February, 1936, refers to his earlier patents on the use of an acid in an oil well, and this one is for a modification of that type of process employing an emulsified hydrochloric acid as the treating medium.

Hund, et al., 2,059,459, filed June, 1936, proposes to employ a non-aqueous acid solution, the acid becoming active upon dilution with water in the producing formation.

Pitzer, 2,080,875, filed March, 1936, for method of and means of treating wells, discloses the idea of exploding a cartridge in the well bore beside the producing formation,

the cartridge walls being loaded with projectiles, and the container cartridge may also contain chemicals, and when this cartridge explodes, it forces these projectiles and the acids, or whatever it is, in the container, into the side walls of the well hole.

Vandergriff, 2,094,479, filed December, 1936, for treatment of wells, consists in injecting into the producing formation a mixed acid solution containing hydrochloric acid and hydrofluoric acid.

Lang, 2,107,007, filed in 1936, discloses in connection with a process entitled "Method for increasing the recovery from oil sands," the use of an acid solution for increasing the permeability of the formation surrounding an input well; that is a well, I understand, that is used for repressuring operations. The particular feature about this process is the mechanical treatment of the well bore before the acid is used.

Clason, 2,122,452, filed 1936, is for acid treatment of wells wherein he has a special way of blanketing off certain formations with a blanketing medium and acidizing the other portions.

Menaui, 2,122,483, filed January 11, 1937, is for "method and means for acidizing wells" wherein there is first put into the well hole what he calls a non-jellifying material in admixture with calcium chloride solution ahead of the acid.

Miller, 2,124,495, filed April, 1936, is for treatment of drilled holes and consists in using hydrochloric acid to de mud well hole when the mud contains calcium carbonate. It is distinguished, however, from that Weir et al. patent previously mentioned by me in that in this case the carbonate used is a solid powdered form, whereas in the Weir et al. it might be an aqueous solution of the carbonate. I believe I might have wrongly stated the nature of the carbonate used in that Weir et al. patent as being solid, and I think it is really a solution that is used.

Loomis et al., 2,124,530, assigned to Shell Development Company, filed 1936, is for "method of treating wells," and

it makes use of water insoluble organic solvents in combination with aqueous acids.

Morgan, 2,128,160, filed 1937, is for well treating fluid consisting of an acid solution containing gelatin or what he calls a protective colloid capable of maintaining the mud present in an oil well in a suspended and dispersed condition in the presence of strong acids.

Morgan, 2,128,161, filed July, 1938, is for well treating fluid, this fluid consisting of an acid solution containing what he calls a calcium sequestering agent.

Bresler, 2,140,183, filed July, 1936, is for method of treating wells, and he uses an acid solution containing barium chloride.

Savits, 2,143,251, filed June 1938, is for method of and equipment for acidizing wells, and discloses a special device in combination with a packer and tube for acidizing independently more than one formation in the same well.

Averson, 2,148,006, assigned to Standard Oil Company, filed October, 1938, is for acidizing a well with sulfamic acid.

Menaul, 2,149,617, filed December, 1936, is for method and apparatus for handling acidic solutions and it discloses that by electrically coupling metallic lead to the tubing of an oil well through which acid is to pass in acidizing the well the tubing will be protected from corrosion.

Owsley, 2,163,449, filed 1938, is for method of treating a well. The use of acid in connection with this has to do with opening up a water stratum into which cement is to be injected so that the cement will enter. Thereafter the water will be shut off, as I understand that.

Lee, 2,171,416, for method of treating a producing formation involves the making of superimposed lateral channels from a well hole and acidizing these channels independently.

Herbsman, 2,172,083, is for method of treating inorganic mineral slimes in oil wells, filed May, 1937, which comprises forming an aqueous suspension of a sulfonated glyceride and introducing the suspension into that portion

of a well in which there are accumulations of slime. The specification states that in treating a slime of the carbonate type, the treating agent is produced by forming a suspension of sulfonated glyceride with an aqueous acid solution. The acids usually used in this solution are hydrochloric acid or acetic acid.

Loomis, et al., 2,177,345, assigned to the Shell Development Company, filed 1938, is for method of treating wells. This consists in employing an acid solution to which acetone has been added, or the like.

Simmons, 2,186,349, filed January, 1937, is for method of acidizing wells, the feature about this being mechanical means and methods for locating the acid where desired in the well hole.

Pitzer reissue 21,356, application for reissue February, 1938. This discloses the same invention as in the previous Pitzer patent, bearing original number 2,080,865.

Robinson, Jr., assigned to the Texas Company, 2,198,563, filed June, 1937. In connection with his process, called "Method of Completing Wells," in which a drilling mud fluid may be used as the circulating medium, and may contain calcium carbonate, he employs an acid solution for disintegrating the mud after the well has been drilled.

DeGroote, 2,204,580, application February 17, 1936, assigned to The Dow Chemical Company, is for acidizing a well with an acid solution containing a preferential wetting agent comprising an alkylated sulpho-aromatic acid.

Herbsman, 2,206,187, filed June, 1937, for "Method of Increasing Production of Oil Wells," consists in introducing a solution of hydrochloric acid gas absorbed in a liquid, which is immiscible with water in the well, a liquid such as oil.

Holmes, 2,224,297, filed April, 1939, for treatment of oil wells, consists in employing a strong acid with salts.

Carr, 2,237,131, assigned to Pure Oil Company, filed December, 1938, for treatment of wells, consists in a process of drilling involving the use of an acid solution not as an aid to the drilling but in certain stages of the drilling,

for the purpose of increasing the porosity of the formations being drilled.

Zacher, 2,234,790, filed February, 1939, for mud wall disintegrator, discloses the use of a weak acid to which a salt of a strong acid has been added for cleaning off the mud from the walls of a well hole.

Mr. Owen:

I would like to ask a question now. In this list of patents you have just read I notice that at least one patent was included which was assigned to The Dow Chemical Company. Will you explain again, in that connection, just what it is you have omitted from that graph with reference to Dow Chemical Company inventions? A. I omitted applications that were of Dow inventors, but I included that DeGroote application, although it was owned by Dow, but we didn't come to own it until some time after it had been filed in the Patent Office.

Q. So that this list does not include any inventions or any patent to inventors who were employees of The Dow Chemical Company subsequent to the Grebe and Sanford patent? A. Yes, sir.

Q. Were any Dow applications omitted which were filed prior to the application for the Grebe and Sanford patent? A. Yes.

Q. Then this graph does not include any patents issued on applications of Dow Company inventors other than the Grebe-Sanford? A. It does not include that one. I haven't included any Dow inventors' applications on which a patent issued.

Q. Then the Grebe-Sanford application on the chart and the arrow pointing to one of the angles is merely to indicate the point where the Grebe-Sanford application would have come had it been included? A. That is correct.

Q. Could you state how many applications filed by Dow Company inventors there are which would have been properly included in this chart had you wanted to make it complete so as to cover all applications? A. The number of applications which have now matured into patents,

the same as the ones I have spoken of, except for ownership, I think there are 28, or thereabouts.

By Mr. Lyon:

Q. This list that you read in answer to my previous question, of the patent applications that are embodied in the curve Exhibit 9½, subsequent to 1932, included many relating to inventions that were not actually on acidizing wells; they relate to various other inventions which involve in some way the use of acid down a well, rather than acidizing inventions? A. That is correct.

Mr. Owen:

That applies also to the part of the chart previous to Grebe and Sanford? A. Yes.

By Mr. Lyon:

Q. Now, it will only take a minute just to complete this information about this curve, if you have it there, so I am going to ask you to identify the particular patents that are responsible for these steps on the curve prior to 1932. You have done that partially, but in looking through the record, I could not make it add up. A. The first kick up is due to the Sherwood patent, No. 57,982, and in that connection I should state that I have assumed that the issue date of Sherwood is the same as the filing date because I did not have any means to determine the date on which it was filed. It does not appear on the copy of the patent. Then the next kick up is due to the addition to that of the Looney patent application, which became patent No. 139,010. The next is due to the two patents issued on applications filed in 1895, the first is Van Dyke, 556,651, and the second Frasch, 556,669. The next rise is due to the Ball patent application which matured into patent 670,577. The next is Muehl, filed in 1920, and issued into 1,410,827. The next is Tilton filed in 1922 issued into 1,608,869. The next is Lake and Phelps, filed 1923, becoming patent No. 1,498,045. The next is Ranney filed 1928, issued as 1,806,499, and the next is Bowman, filed 1929, and issued as 1,809,546.

I did not embody or include in my curve the patent to DeGroote, 1,892,205, of December 27, 1932. I am not especially familiar with that patent.

Q. Well, I think if you look at it you can see quite quickly that it relates to a solution which is put down an oil well to prevent the accumulation of solid matter, and it gives a review of the prior patents of the Tretolite Company on that same subject. They are listed on page 2, the patent to Brady and the patent to Campbell. Are you familiar with those patents? A. I have seen those patent copies, I am pretty sure.

Q. Well, will you tell me why those are not properly included within the list of solvents, chemical solvents employed to aid in a producing well? A. I would have to take a look at that again, but my collections from which this is drawn have been classified to include such patents as involve the use of acid in a well, and since I did not find any others in my group I haven't put them on the chart. I therefore have assumed that my chart completely represents patents that involve the use of an acid, and that these therefore did not.

I considered in connection with the preparation of my charts the Ackerman patent 1,734,990, granted November 12, 1929, and I hand you a copy of that. It mentions sulfuric acid, but it doesn't come under my classification. It discloses a composition of matter which, as Mr. Lyon states, is for the purpose of preventing pipe lines from becoming clogged, and this composition of matter is made up of the following ingredients: Anthracene, 3¼ per cent, sulphuric acid, concentrated—that is 93 per cent concentrated—0.65 per cent, oil of mirbane, or nitrobenzene, 1.3 per cent, naphthalene flake, 66 per cent, sodium hydroxide granular or powder, 28.8 per cent. Upon forming this composition of matter, the sulphuric acid originally present becomes sodium sulphate and the mixture is no longer an acid solution and it, therefore, does not comes under this classification.

I am familiar with the patent to Walker, No. 1,873,083, granted August 23rd, 1932, on an application filed October 30th, 1926, and have it in my collection and have read it. It is my recollection about this that it does not disclose putting acid into a well. Perhaps I have overlooked it, but that was my recollection.

By Mr. Lyon:

Q. The patent refers, does it not, to a method of treating oil wells by lowering fluid, for introducing a fluid into the well to remove scale (handing patent to witness). I think that is what the patent is about. A. The first claim in the patent reads as follows:

"The method of treating oil well liquids to render them non-corrosive and non-scale forming which comprises adding to the well liquids a reagent comprising mixture of an alkali metal salt and a caustic alkali solution of tannin in amounts sufficient to cause precipitation of the insoluble alkaline earth salts upon the well liquids in a pulverulent and non-scale building form."

That, of course, is not an acid solution. It refers to a number of acid substances, but, of course, they are not used as such in this process. It used salts of those acids rather than the acids themselves, and I excluded the patent on that understanding.

I have seen patent 1,804,078 granted to Martin William Baden of Winfield, Kansas, on May 5, 1931, on an application filed November 26, 1928. It was not considered by me at the time I compounded the data for that curve.

Mr. Owen:

I offer books of patents in connection with Charts 9, 9½ and 10. Call the book with reference to 9 and 9½, PX-9¾, and the one with reference to 10 call it PX-10½.

DONALD D. HALL,

a witness called by plaintiff, testified as follows:

DIRECT EXAMINATION

I reside at Midland, Michigan, and am superintendent of the Chlor-benzol plant for The Dow Chemical Company. I have worked for The Dow Chemical Company since 1923.

I am a chemical engineer, graduating from Case School of Applied Science in 1921, and I worked in the intervening time for The Standard Oil Company in Cleveland, Ohio. When I first was employed by The Dow Chemical Company I worked in the salicylates division, doing laboratory work on pharmaceutical products. It is aspirin and those products. Thereafter the Chlor-benzol plant was started up and we did some laboratory work as this plant was being started, and I worked into the superintendency of that particular plant. The primary product of that plant is monochlor-benzol. Hydrochloric acid is a by-product. There is considerable use within the Dow plant for hydrochloric acid, and that took care of quite a large part of it, and about 1931 we began to ship it to customer accounts. We had only a few customers to begin with and first we only had one car, a rubber-lined tank car, 8,000 gallons, in which we shipped the acid; then it gradually developed from that point. The hydrochloric acid is manufactured in standard commercial strengths of 18 Baume, 20 Baume, 22 Baume, and recently we have a stronger acid. Prior to 1932 we shipped it in standard commercial strengths. As this acidizing of wells developed we began to supply that acid in 15% strength.

I have our record of shipments of hydrochloric acid for the year 1932 with me. The first shipment I find in our record reads as follows, it is the second shipment of the month, dated February 11, Order No. 38,118, to the Pure Oil Company of Mt. Pleasant, Michigan, of one wagon of

15 per cent HCl, 790 pounds 100 per cent HCl. That was on February 11, 1932. I don't know what particular well that went to.

By Mr. Owen:

Q. Was anything placed in that 15 per cent acid before it was shipped on the occasion to which you have referred?

Mr. Lyon:

Well, I don't think the witness has laid any foundation for that answer. As far as I know he has only identified this book. He hasn't stated that he manufactured the acid or remembers the transaction. Maybe he does, but I think your foundation should be laid.

Mr. Owen:

He stated he was in charge of the Chlor-benzol plant of the Dow Chemical Company.

The Court:

I will let him answer. You can cross examine him and see how far wrong he has gone in saying he knows. I will let him answer. A. Yes. We secured arsenic acid. We obtained that in a two gallon glass bottle from the lead arsenate plant and put it in that shipment. That is another plant within the Dow organization. I personally know that that two gallons of arsenic acid was placed in this 500 gallon shipment of 15 per cent hydrochloric acid. I did not do it myself, but I secured the acid. I had to use the telephone to secure the arsenic acid and have it delivered and gave the orders to the men to put it in. I can't say that I saw it put in but I am satisfied it went in that shipment.

The Court:

Did you put it in so it wouldn't eat up the tank that carried it? That is the purpose of it? A. Yes. I presume that is the purpose.

Mr. Owen:

Q. Do you recall what kind of a tank that acid was placed in at your plant? A. I think that first one was a wooden tank wagon that was placed on a truck; rather, this whole thing was gotten together rather hurriedly in order to get it to the field as quickly as possible.

The Court:

Then, it wouldn't be for the protection of the tank?

Mr. Owen:

No, it would not. It was for the protection of the tubing in the well.

The Court:

In the well?

Mr. Owen:

Yes.

The next shipment I find in my record of 15 per cent hydrochloric acid was made March 11, 1932. It was virtually a duplication of the previous shipment, 500 gallons of 15 per cent acid. Two gallons of arsenic acid. The next shipment was on April 5, 1932. That was 15 per cent acid with the two gallons of arsenic acid. 500 gallons of acid. And the next shipment was April 27th. Those were all in the same amount. Each shipment contained two gallons of arsenic acid. Those shipments were all made to the Pure Oil Company. Other shipments were made to the Pure Oil Company on May 5th, 21st, 25th, 27th, 28th, and 31st. Those shipments all were the same as the previous ones, 500 gallons of the 15 per cent hydrochloric acid, and containing 2 gallons of arsenic acid. In the first half of June there were about eight shipments, that is, June 1, 3, 4—there were two on the 4th—on the 7th, 9th, 11th, 13th and 15th. Those were all of the same amounts of acid and in each case the acid contained the two gallons of arsenic acid. Four of those were made to the Pure Oil Company, and four to miscellaneous other companies, three to the Columbia Oil & Gas Company, and two to Lawrence Lee.

The Court:

Can you give me some idea as to how much of this was used in acidizing a well? A. Well, they would sometimes come in for a second load to put in the same well. I think originally they only used about one 500-gallon treatment, but later on they began ordering larger amounts. I cannot answer as to the practice in the field.

The Court:

But you think they used at least the one 500-gallon tank in a well?

Mr. Owen:

That is the fact, Your Honor; and now the treatments run up, I understand, as high as 10,000 gallons for one treatment. They started in with 500 gallon treatments.

The Witness:

During the last half of June, 1932, there were 23 shipments of this 15 per cent hydrochloric acid, part of them to the Pure Oil Company, and the others to miscellaneous users. Others than the Pure Oil Company receiving those shipments were The Chippewa Oil & Gas Company, the Mt. Pleasant Oil & Gas Company, W. L. McClanahan, Lawrence Lee, the Talbot Oil Company, the Gordon Oil Company, the Storkwell Oil Company, the Michigan Gas & Oil Company, the Luther Drilling Company and Ohio Producers & Refining Company, the balance being for the Pure Oil Company. Some of those shipments were for 1,000 gallons instead of 500 gallons. In the thousand gallon shipments, four gallons of arsenic acid were put in.

During July, 1932, 51 shipments of this 15 per cent acid were made. Those were either for 500 gallons or 1000 gallons of this 15 per cent hydrochloric acid, with the proportionate amount of arsenic acid.

Q. Will you name the different companies or individuals to whom those shipments were made during July, 1932?

Mr. Lyon:

I might suggest if counsel had some kind of a schedule of this, or table of it, or some summary, we don't contest the shipments at that date after the filing of this application, and you can put it in much quicker than calling the witness.

Mr. Owen:

We have such a summary made up which the witness is testifying from.

The Court:

You can call it an exhibit, and I will admit it.

Mr. Owen:

I will offer that summary, then. It goes up to and including November 10, 1932, which was the date when Dowell, Incorporated, was organized and took over the business.

Mr. Lyon:

You say it is a correct summary, or if you say the witness will testify it is a correct summary, why, we will receive it as such without any argument about it, Your Honor.

Mr. Owen:

We will ask the witness about this.

By Mr. Owen, continuing:

Q. Is this a correct summary of the entries in your original book of entries for that period? A. It is essentially correct. There may be one minor typographical error, of which I am not familiar.

Q. At least you haven't put any entries on this summary that are not in the book? A. To the best of my knowledge it is correct.

Mr. Owen:

I will offer that as Exhibit 12.

(The summary above referred to was thereupon marked PX-12.)

CROSS-EXAMINATION

The order number for this shipment which was made on February 11, 1932, and which I state was the first shipment of 15 per cent hydrochloric acid made by the Dow Company was No. 38118. The shipment record reads: "Product: Hydrochloric acid. Month of February, 1932," and shows only seven orders during that month. It was the only one of those orders showing 15 per cent hydrochloric acid. Independent, down below all these entries, is written in there 2 gals. arsenic, Pure Oil. Relative to the making of these seven entries, that was put on there at the same time or at the end of the month. In a later case, we had a trans-

fer between the lead arsenic plant and the Chlor-Benzol plant of our arsenic acid. We got it in two gallon glass bottles, and we had to account for that, and we put it in our inventory which had to be turned into the accounting department. It was credited to the lead arsenate plant and charged to our plant. I can't say whether it was charged to the Pure Oil Company. The Sales Department would bill the Pure Oil Company either for the acid, the arsenic acid, or for the combination, and I don't know how it was handled. I think this entry, 2 gals. arsenic acid, Pure Oil, is my handwriting. Most of these,—quite a number of these are my handwriting, but they are not all my handwriting. Mr. Reid made several notations. This is my writing. Here is Mr. Reid's writing here. I think I put this notation on this particular sheet at the end of the month, but I am not absolutely sure. I have had this shipment record in the file in my office since 1932.

The records of which you show me photostats for the month of June and the month of July, 1932, are abstracts. We have no other shipping record of these shipments than the book I have produced. What you have shown me are abstracts. This is the original shipping record right here.

Mr. Lyon:

Q. That does not seem to be the same either, because you can't identify these sheets that I have shown you the photostats of? A. They are not taken directly from this record. They appear to be an abstract of this record. The order numbers are the same, but they have omitted, I think, shipments such as some of our commercial shipments of 18 and 22 Baume acid.

Q. Now let's go back to the February 1932 shipping record, your original shipping record. In what form did you receive instructions to make the shipment to the Pure Oil Company February 11, 1932? I notice your shipping record shows order #38118. A. That is the regular Sales Department order. I received such an order from the Sales Department.

Q. Was it specified on that order that you should

also ship some arsenic acid? A. I can't answer that definitely, I am afraid. We had instructions to do that. Whether it was printed on the order or whether it was phoned in to us, I can't say.

Mr. Owen:

You don't mean, Mr. Lyon, to infer the arsenic acid was shipped separately from the hydrochloric?

Mr. Lyon:

I am trying to find out—

Mr. Owen:

(Interrupting.) The form of your question indicated the arsenic acid was shipped separately.

Mr. Lyon:

Oh, no, no. I didn't mean to infer that. This shipping record has some lines below the last entry for the month, just a notation "2 gal. arsenic Pure."

Q. It doesn't say what about it any more than that? A. That is the only Pure Oil shipment of the month.

I think I probably put that notation in at the end of the month. I can't say whether the order I received from the Sales Department for this shipment #38118 showed that we were to include with that acid that arsenic. I do know some of the orders received did specify. In later shipments the orders did specify we were to add the arsenic, I remember that. The photostat you show me of order 38118 looks like one of our orders. It has the correct order number.

Mr. Lyon:

I will ask counsel if there is any question about this photostat being a correct photostat of the order in question (handing same to Mr. Owen).

Mr. Owen:

There is no question but what that is a photostat of the order.

The Court:

It's good enough for me if they want to put it in the record.

Q. You don't find on that order any reference to any

shipment of arsenic material, do you? A. It doesn't appear on this order.

This shipment record for March begins and sets forth, commencing at the top, consecutively down, that we made six shipments of hydrochloric acid from our plant in March, 1932. And then below that there is a total of the March sales and some percentage figures of some kind. And then down below, several lines further down, entirely detached, is what appears to be a notation "2 gal. arsenic Pure Oil." I believe that is in my handwriting. That probably was written in there at the end of the month.

Q. Why wasn't it included in the entry for the shipment at the time the shipment was made? A. The purpose of this is to provide accounting for all materials used or sold. At that time we didn't make individual entry of that two gallons, evidently. There may have been other shipments in the balance of the month. Our purpose was to put down the total in order to account for the material.

The photostat you show me of order No. 3537 of The Dow Chemical Company, Pure Oil Company is the order 40327, the order number for this March shipment to the Pure Oil Company. It does not show any reference or contain any item calling for the shipment or the inclusion of the arsenic.

Mr. Lyon:

I understand counsel to say that there are no bills showing the inclusion of the arsenic material for the February shipment, and I would like to have—

The Court:

He didn't say that he was sure about that.

Mr. Owen:

No, I am not sure about that. We are willing to produce whatever we have.

Mr. Lyon:

Well, I would like to have the bill for this March shipment, if you can get it.

Mr. Owen:

We will produce the bills for the first—how many would you like, Mr. Lyon?

Mr. Lyon:

Just for those two (indicating).

The Court:

When do you claim that you began to charge for this?

Mr. Owen:

I think the first charge was on March 11, 1932, at least that is my understanding.

The Court:

And you think they kept it up after that?

Mr. Owen:

Yes.

The Court:

Well, you can bring in the first two, and then be prepared to tell us if you did charge for it every time thereafter.

Mr. Owen:

To the Pure Oil Company. I think possibly that free treatments were given to some other oil companies, just to get them interested.

The Court:

I see.

The Court:

Do you charge so much a gallon, or do you do like they do in automobile concerns, make a charge for time and material both?

Mr. Owen:

I think they charge a lump sum for the material and the—

The Court:

Then you are not going to get what you expect. This is an inter-departmental charge that you have got here.

Mr. Owen:

Yes.

The Court:

If it turns out the way he thinks, it is going to be different from what you think. I understand that they just made a lump charge of so much for a well, is that right?

A. I cannot answer for the accounting end of it.

The Court:

Did you say that it was labor and material?

Mr. Owen:

I think that will all be cleared up by a later witness, who will undoubtedly have access to these records. We were selling service. We did not charge merely for the acid. We made a lump charge for the acid, including the service of putting it into the well.

Mr. Lyon:

We have the order number. We have certain photostats of later orders, Your Honor.

The Court:

But, what I understand, those are inter-departmental orders.

Mr. Lyon:

They show a charge, they show an order from the company and they show one part of arsenic acid, $3.19 to be charged, I suppose, to the company.

The Court:

I don't know. That is what they are going to let us know.

Mr. Lyon:

That is what the customer is ordering on the order sheet.

The Court:

Is this an order from the customer or an order from one department to another? A. Those are the orders we receive from the sales department to make the shipment. That is not an inter-departmental order.

Mr. Owen:

This is not a billing to the customer, is it? A. No.

Mr. Owen:

It is an order. A. It is our order to make the shipment.

Mr. Owen:

It is an order to your department to make the shipment. A. That is right.

The Court:

I thought it was a department order. One department to another.

Mr. Owen:

That is what it is, Your Honor.

A. It is from the sales department to the plant to ship.

Mr. Lyon:

Do you know whether they bill the customers for any of this arsenic acid on the bill? A. The billing is an entirely different department. I can't answer that.

The Court:

Different price, probably, too, but we will have to find out about it. You are just guessing, you and I.

Mr. Lyon:

So that I can explain the point, we will offer proof to show under this patent to the Pure Oil Company, the Pure Oil Company went to the Dow Company with their invention in December, I think, 1931, and it is our understanding that actual shipment of ordinary acid, commercial acid, without any inhibitor, was made to the Pure Oil Company and used by the Pure Oil Company in acidizing wells; couple that evidence with evidence when this application was filed, and prepared,—the information was, it was written down, that this use of this inhibitor was optional and not necessary in the process, and now that they are finding there is nothing to talk about it in the language of the patent except the inhibitor, they are making the inhibitor their all-important thing, whereas it started out with the Pure Oil Company idea of reviving the old Frasch process.

The Court:

This is mighty important, what we are talking about here now, and the very fact that is written on afterwards. I don't mean there was a juggling of the books for the Patent Office, but it may be it was put in their order, and you filled out the order for that, and somebody went back and thought they used two gallons in everyone of those. I don't know what. But, if it seems to be inserted in there, we better get to the bottom of that.

Mr. Owen:

We will try to clear that up, Your Honor. Now, the next thing I have is Mr. Hall's shipping record. Mr. Hall was a witness, Your Honor will recall, and he produced a typewritten list of acid shipment records which is in evidence as PX-12. On cross examination counsel called attention to the fact that the shipment record of hydrochloric acid for February, 1932, has an entry "2 gal arsenic Pure Oil" written at the bottom below the other entries, and Mr. Hall testified that he couldn't recall when he made that entry, which he thought he made at the end of the month.

Now, in order that the record may be complete I am going to offer a photostat copy of the sheet containing the shipment record of hydrochloric acid for each month during the first half of the year 1932.

And I call attention to the fact that in the January sheet there is no entry showing a shipment of hydrochloric acid to the Pure Oil Company, and there is no entry showing a shipment of any arsenic acid during that month; that in the record for February there is one item, which is No. 2 on the sheet and reads:

"2-11, order No. 38118, Pure Oil Co. Mt. Pleasant oil field, one wagon, 15 per cent HCl," and then under the column "Net weight," "790," and down below the other entry, there are seven entries in a row, and then below that is written this entry:

"2 gal. arsenic, Pure Oil."

In the March sheet item No. 2 is dated 3-11, the order is 40327, Pure Oil Co., oil field, it looks like 5000 pounds of 15 per cent, and underneath "Net Weight," "750."

Then down below the other entry is an entry similar to the one on the February sheet, reading:

"2 gal. arsenic, Pure Oil."

On the sheet for April there are two entries indicating shipments to the Pure Oil Co., No. 2 being dated 4-5, the order number 42,252, Pure Oil Co., Oil field, one tank W., looks like 68 cubic feet, 15 per cent HCl. It is not very

clear. The net weight is 750, and item 4 is dated 4-7, or 2-7, I can't tell. I think it is April 7th. The order is 44094, and the consignee is Pure Oil Company, Mount Pleasant, Michigan, one tank W. 68 cubic feet, 15 per cent, and the weight is 750.

And at the bottom of that, or below the entries on that sheet appears this entry:

."4 gal. arsenic acid, Pure Oil."

The next is the shipping record for May, 1932, and it contains six shipments to the Pure Oil Company, Mount Pleasant, Michigan, being Nos. 2, 6, 7, 8, 9 and 10 on the list, and the amount of the shipment is 750 net pounds in each one, net weight, and below on the page is this entry:

"12 gal. arsenic, Pure Oil."

Then there are two sheets for June, and they contain, as I count them, 13 shipments to Pure Oil Company, and then shipments to other companies, the Columbia Oil & Gas Company, and different ones; and at the bottom appears this entry:

"44 gal. arsenic, Pure Oil; 28 gal. arsenic, Misc."

Now, some of those Pure Oil shipments were of 1500 net pounds, instead of 750 net pounds. For instance, entry No. 21 was for 1500 pounds, and entry No. 23, entries 24, 25, and 26, each for 1500 net pounds, and No. 28 also, and No. 31, and No. 33—those were all shipments to the Pure Oil Company.

Mr. Owen:

So I will ask that copies of those sheets for January, February, March, April, May and June of 1932 be photostated and offered in evidence as one exhibit, and marked PX-246.

The Court:

That will be done.

(The photostatic copies will be marked Plaintiff's Exhibit No. 246.)

The Court:

The purpose of the reading was so that the record might show the portions of this that you relied upon?

Mr. Owen:

Yes. The purpose of it was this, that those shipments to the Pure Oil Company of hydrochloric acid, and the entries of shipments of arsenic acid to the Pure Oil Company, register in every instance 2 gallons of arsenic acid to 500 gallons of hydrochloric acid.

The Court:

The first one was no charge?

Mr. Owen:

The first one was no charge, but the entry of arsenic acid is the same.

The Court:

The same for that one?

Mr. Owen:

Yes. And then it is there for the second, third, fourth, and so on.

Mr. Lyon:

It is not in accordance with the keeping of regular books. It is down at the bottom.

LAWRENCE W. LEE,

a witness called by plaintiff, testified as follows:

DIRECT EXAMINATION

I am an employe of Dowell, Incorporated, and I live at Midland, Michigan. I have been an employee of Dowell, Incorporated, since 1932. Previously I was employed by the Dow Chemical Company since 1928. I was in the Service Department of the Dow Company and had charge of trucks, yards, and the general clean-up of the plant. I recall the time when the first oil well was acidized by the Dow Chemical Company for the Pure Oil Company. Our particular department transported the acid from the plant to the well location, it was my duty to secure a receptacle from the Acid Division in which to transport the material. The container for the acid was a wooden tank normally used by the Acid Division for transporting acid between plants. That was the first time one of those tanks had been used for such purpose, as far as I know. That was in 1932. I know that from tying it into other treatments which came later and in which I was personally interested. That first shipment made to the Pure Oil Company was before May of 1932. It was approximately sixty to ninety days before May.

By Mr. Owen:

Q. What is there about May that fixes this in your mind? A. In May of 1932, I made arrangements with the Dow Chemical Company to secure some inhibited acid, and the services of one of their men, for treating some wells in which I was interested.

I actually saw the inhibitor go in the first well that was treated for me, and I had knowledge of their previous use of inhibitor in the acid they were using in the wells of the Pure Oil Company. I knew about that by discussions with Ross Sanford, whom we worked with very closely, and with Dr. Grebe of the physical laboratory.

Q. And when, with reference to that first shipment of hydrochloric acid to the Pure Oil Company well, did you have occasion to have conversation, the first conversation with Dr. Grebe and Mr. Sanford, or either of them, on the subject of an inhibitor in that acid? A. The first conversation with Dr. Grebe was previous to the Pure Oil treatment, and it occurred after our department had trucked acid in carboys to a Dow well directly in front of the office from which we operated. And the purpose, my purpose in talking with Dr. Grebe was to find out what protection we should give our men in handling the acid which was going into this well. And at that time we discussed the handling of the acid and the manner in which it was going to be put into that well. That was previous to the first Pure Oil Company treatment. In my opinion it was a few months before. I do not recall whether or not during that conversation anything was said on the subject of inhibiting the action of the acid on the well equipment. I first learned that an inhibitor had been used or was to be used in this first Pure Oil treatment about the time I was making arrangements for securing the tank to take the acid to the field for that particular treatment.

Q. Then before that treatment was made you had information or had been informed that they were going to use an inhibitor in the acid; is that correct? A. Yes, sir.

Mr. Lyon:

I object to that as leading and suggestive.

The Court:

"About the time," I would rather you wouldn't—let's let him fix it as near as he can with reference to when he actually took it out. That is all that we can get now. A. It was at the time that the first treatment went to the field of Pure Oil that we discussed the use of the inhibitor.

The Court:

At the very time, you mean? A. Yes, sir.

The Court:

The very day? A. Within one or two days. It was at the time we took it up.

By Mr. Owen:

Q. How are you able to state that you talked about inhibitors at or within one or two days of the time of that first Pure Oil treatment? A. Well, in discussion of how it was to be handled Mr. Grebe stipulated that Mr. Quinlan, who worked for Grebe in the lab, was to put in the inhibitor and would handle the mixing of it, as there was danger in handling the material that they used.

I learned at that time that the inhibitor they proposed to use was arsenic acid. It was to be obtained from the lead arsenate plant. It was a product or by-product of that plant.

Q. Now, after that first treatment, when did you next discuss this question of an inhibitor being used in the acid, if at all, and with whom? A. The next time that I can remember discussing the use of the inhibited acid—

The Court (interposing):

Is that the first acid that went to the field? A. That is the first acid that went to the field; yes, sir, to the Pure Oil well.

The Court:

Now, is there any relation between that—you have already told us about using a wooden tank? A. Yes, sir.

The Court:

Did the talk have anything to do with the wooden tank? A. We had to secure a tank or some receptacle for taking it to the field.

The Court:

Yes, but what about this emphasis of the wooden? Was that emphasized in any way when you talked about it? A. No. That is the only receptacle we had at the time for taking it to the field.

The Court:

That is the only one you had? A. Yes. I made contact with Mr. Curtiss of the Sales Department for the purchase of sufficient acid to treat five wells, five hundred gallons to each well, and it was stipulated that Mr. Quinlan would have the inhibitor and assist or supervise the treating of the wells, and that was done.

Q. I call your attention to Exhibit 12 in this case, which is a list of shipments of inhibited acid produced by Mr. Hall, and on this list I find under date of 6/4/32 an entry of a shipment to Lawrence Lee of 500 gallons of 15 per cent acid, and a note on the margin of the use of arsenic in connection with it.

This was one of the treatments that I have just referred to. On that treatment I saw the inhibitor go into the tank. The entry under the date of 6-9-32 also was one of our wells. I do not know by definite observation whether or not an inhibitor was used in that acid. There was an understanding on that subject. All of the acid to be bought was to be inhibited acid.

Mr. Lyon:

We are not contesting that. It is in agreement. You can put that summary in. We agree, commencing in June that these wells were treated with inhibited acid, with acid containing inhibitor.

Mr. Owen:

Well, then, I won't pursue that line any further.

The Court:

Well, now, the first well this witness has testified about was in 1932?

Mr. Owen:

The first well he was personally interested in; the first well he has testified about was the Pure Oil Well treatment of February 11, 1932.

The Court:

All right. What has he said about the inhibitor in that?

Mr. Owen:

Will you repeat what you said about the inhibitor in that first treatment for the Pure Oil Company? A. I stated that I personally made arrangements for obtaining the receptacle in which the acid would be transported to the field and I stated that I discussed the use of inhibited acid with Mr. Quinlan and Mr. Grebe previous to that at the time.

The Court:

You had to do with the transporting, as I understand? A. Yes.

The Court:

Why were you concerned whether it was inhibited or not? I find no connection for the reason you happened to do that. A. I am responsible for the men in that division and our men were handling the material. They were loading the acid and would be transporting it to the field. The information regarding inhibitor was advanced by Mr. Grebe's department inasmuch as he considered there was a certain amount of risk in putting in the acid or handling it physically, and he wanted his own men to put the inhibitor in instead of the men from the Service Department.

Mr. Owen:

I think what the court wants to know is how you happen to know so much about furnishing the truck for that first equipment. A. Dr. Grebe discussed the handling of the acid. I am talking about the arsenic acid, which is the inhibitor which goes into the tank.

The Court:

Is that dangerous to a man? A. Dangerous if it gets on your hands, finger nails.

The Court:

More than the hydrochloric? A. Yes, sir.

The Court:

I know acids and I don't see why a chemist would discuss with the trucking department what kind of acid.

Witness:

I worked for the Dow Company up to about the time Dowell was incorporated and then went over to them. My first duties for Dowell Incorporated were building of equipment, starting stations in the field and the operations in the field. I installed stations during the early period at Louisiana, three stations in Texas.

The first station was opened at Midland, Michigan, operating from The Dow Chemical Company; the next station at Muskegon, opened in September, 1932. Our depart-

ment moved the equipment over there, and two of our men from that department were transferred to that station about that time. The next station was opened in North Baltimore, Ohio. I was working with Dowell at that time, at the time that was started. Horse Cave, Kentucky, was the next station. Manning, Louisiana, was the next station. That was started in December of 1932, although no equipment arrived until January of 1933. Texon, Texas, in January of 1933. Russell, Kansas, approximately the same time, in January of 1933. Then Breckenridge, Texas, in February of 1933.

I am now in charge of the purchase of materials, auxiliary treating materials, and have been in that branch of the business since March of 1933. Since that date I have had knowledge, through my purchasing of materials, of what was being used. My records show what this inhibited acid was called. It was called Dowell X. They started calling it Dowell X in 1933. At one time before that it was known as Dow limestone solvent. It has been called Dowell X since that name was adopted. That indicates in our accounting, inhibited hydrochloric acid of 15 per cent strength.

The advertisement, photostat copy of which you show me, appeared in the Oil and Gas Journal for December 1st, 1932. This advertisement is familiar to me. I saw it at the time it came out.

Mr. Owen:

I will offer that as Exhibit 15.

(The photostat of advertisement referred to was thereupon marked PX-15, July 24, 1941.)

CROSS EXAMINATION

Referring to this first order for the job of the Pure Oil Company, dated February 11, 1932, I saw the load leave the yard, I saw the load leave the service station.

By Mr. Lyon:

Q. Are you sure that that was not called for by the Pure Oil Company with its own truck? I will show you the order to see if that will help you refresh your recollec-

tion (indicating). It specifies on the order, to be called for by the Pure Oil Company truck (handing the document to the witness). A. (After examining the document): I would think that it would be called for by the Pure Oil Company if this order says so. I have no actual recollection as to whether it was or not. It was shipped in a wooden tank, I am sure of that. I made the arrangements for securing the tank.

Q. Did you actually see the shipment, see the wooden tank put on the truck? A. I saw the—no, I would not say that I did.

The Court:

Just let me understand you. If they called for it with their truck, would that still mean that it was in your tank? A. Yes.

The Court:

You know that it would not be in their tank? A. Yes.

The Court:

Obviously, a truck used in that business, might go over and get stuff dumped into it and go away with it, but that is not right in this case? A. That tank when it came in would have to come in the gate, and when they came in with the tank—

The Court:

You mean tank or truck? A. When the truck came in, it would come in the gate, and it would come over to the department where the tanks were. Then it would have to be taken from the wooden trucks on which it was carried around the plant, and put up on their truck, if their truck was used, and tied down when loaded. A wooden tank would be put on another flat bottom truck.

The Court:

They don't have trucks like we use for the threshing machine? A. They do now, sir. They didn't at that time.

Q. Didn't the Pure Oil Company have such tank? A. Not at that time. They later built a tank.

Q. Now, why was it necessary to ship the acid in a wooden tank? A. I don't know as it was necessary. That

was the only receptacle we had in the plant which was available for that use.

Q. You did not have any other tank in the plant at all except a wooden tank? A. That was the only thing we were using for acid at that time.

Q. I understand that. Why did you use a wooden tank for acid? A. Hauling acid you would naturally think of the acid receptacle that you had around the plant.

Q. I mean why did you have wooden tanks around the plant to carry acid? A. The acid hauled around the plant is raw acid.

Q. And, you had never thought here in the Dow Company of adding an inhibitor to your acid so that it wouldn't corrode metal tanks if you used metal tanks? A. Well, I am not an authority. If you want my opinion I would be glad to give it to you.

Q. I am trying to find out why did the Dow Company go to the trouble of handling the acid in wooden tanks. Was it because— A. (interrupting) They want the acid in the pure form. They are using it in a process.

Q. What process? A. Processes around the plant. They are hauling from one plant to the other in their work, and manufacturing processes. It is taken from one plant to another for use in reacting other processes.

Q. Do you know whether the inhibitor would interfere with any of these processes that the acid was to be used for? Do you know that of your own knowledge? A. No.

Q. Well, how long was it after this shipment to the Pure Oil on February 11 before your company got a steel tank to handle acid? A. The first record I have is in August or September of that year. They may have been built earlier. I don't know. Then after that we shipped our acid from the stations out to the wells, to the point of use, in steel tanks and the acid contained the inhibitor. The inhibitor was added at the station. We have continued that practice up to the present time since at least Septem-

ber, 1932, that has been the regular practice in our company.

We started using arsenic acid as the inhibitor and continued it until the fall of 1932. We then used an inhibitor which we call Retarder, made in our own plant. I am not familiar with the contents of it, but understand that it was a mercaptan base material. Mercaptan is a sulphur compound. I don't know where it came from. You can smell it in some of these Michigan oils. We have used it at intervals. We are still using that same inhibitor in refined form. It is the principal inhibitor we have been using practically all the life of Dowell. That is, we have used it all through Dowell. And at the present time it is the only inhibitor we are using, with the exception of one other inhibitor, which is a material purchased from the Barrett Company. They sell it for pickling. They sell it to the trade as a pickling compound. It has been about a year since our company has used any arsenic acid or other arsenic compounds or agent.

All the acid that we transport out to the field from our stations contains an inhibitor, and in many cases this added surface tension reducing agent, and it is that acid which you pump down or introduce into the well through the well tubing. For some time we bought an inhibitor from the American Paint Company, from 1934 to 1936, or 1937. I believe that we bought our first in late '34 or early '35, and we bought our last in '36, I believe. That was an inhibitor or a pickling compound called Murodine. We used that for several years in conjunction with our own material as a retarder. In some cases we have used it alone. When we used it in conjunction with our own material, we mixed it with our mercaptan. We bought the Murodine from Mr. Gravell's company, the American Chemical Paint Company.

RE-DIRECT EXAMINATION

We now use wooden tanks for transporting hydrochloric acid from one of our plants to another. As to whether we ever used any other kind of tanks for that purpose, we have used some rubber lined tanks and may be using them now. I am not positive of that. But we never used any unlined steel tanks to my knowledge.

The reason why steel tanks, unlined steel tanks, are not used for shipping or transporting acid from one plant to another in our plant at Midland is because the raw acid would attack the steel tank. There is no reason for inhibiting it in the tank from one place to another, and lots of the processes in the plant, in my opinion, there is a possibility that it would throw off the reaction. We wouldn't want to use it. In other words, pure hydrochloric acid or commercial hydrochloric acid is desired for reaction in our plant.

RE-CROSS EXAMINATION

In our company ever since September, 1932, we have used unlined steel transportation tanks for conveying the acid from our stations out to the wells in which it is to be used. Since we first started, that would be August or September, or in that summer, 1932, to my knowledge we have only transported acid to our customers in unlined steel tanks.

RE-DIRECT EXAMINATION

When The Dow Chemical Company first began to acidize oil wells for the purpose of increasing production there was no one else in that business, to my knowledge. There was some competition started in Michigan in the summer of 1932. That was a firm known as the Oil Makers. It constituted Edgar S. Lee and a man by the name of

Dougherty. They continued in business about a year, I think.

The Court:

Where were they located? A. Edgar is my brother. Located in Midland, Michigan. Dougherty is the driller on the wells which were treated by our company or myself, the driller that drilled the wells.

Q. And were they working under any arrangement with the Dow Company? A. I think that they purchased inhibited acid for one or two treatments but outside of that, they got their material from other sources. I do not know why they stopped.

Mr. Lyon:

If Your Honor please, I think this evidence about other people is immaterial and irrelevant. It is subsequent to the application for the patent. How would we meet it or what collateral issues would it bring in in this case if we wanted to question why it stopped? It isn't worth trying, I don't believe, all those matters.

The Court:

It is material in that it shows the growth of the business; that theory that revolutionized the business along that line. As they started up, others tried the same thing.

Mr. Owen:

That is the purpose of it.

The Court:

It hasn't very great weight, I will assure you of that, but I will let you show it.

Witness continuing:

A man by the name of Ricou, Shreveport, Louisiana, and a company later known as Chemical Process started along about that time, thereabouts. It would be the fall of '32 or early '33.

The Court:

Where were they located? A. In Breckenridge, Texas. Williams Brothers Company came into the picture in 1933, I believe. They were the ones that were sued.

RE-CROSS EXAMINATION

I have heard of The Chemical Process Company. They started in business in the fall of '32, as near as I know. They are still doing some business. Their main office is at Breckenridge, Texas. They operate in Texas, operate some in Oklahoma, I believe they are operating some in Louisiana, and some in Kansas. They have no rights to operate under the Dow patents, to my knowledge.

Q. And you don't claim that they use inhibited acid? A. I don't claim anything about the process.

Q. Don't you know what they use? A. No, sir. Their business is acidizing oil wells and they are a direct competitor of the Dow people and have been before the Halliburton Oil Well Cementing Company went into this business. They are still in business and we are not now suing them, to my knowledge. I wouldn't know whether we sued them in 1934.

Mr. Lyon:

If Your Honor please, I will offer in evidence at this time a certified copy of the papers on file in the United States District Court for the Eastern District of Oklahoma in the suit entitled The Dow Chemical Company, plaintiff, vs. The Chemical Process Company, defendant, in Equity No. 4523. This consists of a bill of complaint for infringement of the Grebe-Sanford patent, an answer filed by the defendant, a set of interrogatories propounded to the defendant, the defendant's answers to the interrogatories, and a stipulation that the cause be dismissed, and an order dismissing the cause.

Mr. Owen:

Dismissal without prejudice.

Mr. Lyon:

I will ask that this be marked Exhibit 16. (Exhibit 16 marked.)

FRED H. BROWN,

a witness called by plaintiff, testified as follows:

DIRECT EXAMINATION

I am assistant treasurer of the Dow Chemical Company. Previously I was assistant secretary for about four or five years. As assistant treasurer I have access to the accounts of the company, and here produce the records of shipments of 15 per cent hydrochloric acid by Dow Chemical Company to the Pure Oil Company, beginning in February, and running on through for several months during 1932.

By Mr. Owen:

Q. Will you explain what these are that you have produced? A. The first bundle is our original invoicing instructions consisting of ten sheets. The first sheet is dated February 11, 1932, and it is made out to our Chlorbenzol department. This form is filled out by our sales department and goes in duplicate to our traffic department. This buff copy is retained, and the yellow copy goes out into the plant. The ones I have produced are retained in our traffic department, and a yellow copy goes out into the plant or the department to fill the order. All of the typed information with the exception of the price is on that yellow copy. That first one happens to be a no charge order.

Q. And the next one, which is Order No. 40327, has typewritten matter and also the entries in pencil. Will you explain what those entries are? A. Well, all the typed material, all the typing is on the form which goes into the department, with the exception of the price.

The Court:

The sales department makes out the typing? A. Yes, they make all the typing. The sales department fills in the price in the copy which it keeps, but the price doesn't go on the copy to the other departments.

Referring to the typewritten matter on this first order No. 28118, the department is "Chlorobenzol" dated "February 9, 1932," and the "Invoice To" block is written "Same," because it says "Ship to Pure Oil Company" and if they are the same we usually write "Same" up there, and the X "Ship to" is "Pure Oil Company, Mount Pleasant Oil Field," and "To be called for by Pure Oil Company Truck February 11th." Down below there is originally written "70 carboys hydrochloric acid," and in parentheses "Strong," and "No charge" in the price column. "70 carboys" was later changed to "one wagon load."

Then on the second one of these orders, which is Order No. 40327, under department is "Hydrochloric Acid" and in parentheses "Don Hall" in charge of that department. Dated March 9th, 1932. Invoice to "Same" "35 East Wacker Drive, Chicago, Illinois." The date to be shipped is "Will call for March 10, 1932." It was shipped to Pure Oil Company oil fields, and the route is "Pure Oil will call for," and the special instruction to traffic and shipping clerk "Pure Oil will call for March 10, 1932." The shipment was to consist of 500 gallons approximately 10 degree Baume hydrochloric acid to be loaded in tank wagon, and there is a "plus handling charges" and "crlc" or whatever.

The Court:

Would that be about fifteen per cent, when it is all loaded?

Mr. Owen:

It is just about fifteen per cent.

Q. Now, the order No. 42252, which is the next one, I see is to the same department and to the same company, the Pure Oil Company, the same shipping instruction. Will you read what the shipment was to be? A. Five hundred gallons approximately 10 degree Baume hydrochloric acid, plus two portions arsenic acid. Total $6.38, and labor tank service transferring charge, that is $5.80.

For order 40327 there was a total charge of $22.18. It

was 500 gallons approximately 10 degree Baume hydrochloric acid, figured out at 4500 pounds, at $14 per ton, on the basis of 18 degree acid, came to $17.50. And then there is a handling charge, $4.68, making a total of $22.18. The next invoice or the next order, 42252, calls for 500 gallons approximately 10 degree Baume hydrochloric acid figured out to 2500 pounds at $14 per ton on the basis of 18 degree acid. That is a total of $17.50. Plus two portions arsenic acid, $6.38. And labor tank service transferring charge, $5.80. Total $29.68.

The invoicing date of order 38,118 was February 11, 1932. Order 40327 invoicing date was March 11, 1932, and order 42252 invoicing date was April 5, 1932.

The Court:

Does that make three or four shipments of acid?

Mr. Owen:

Three.

The Court:

And the first one no charge?

Mr. Owen:

No charge. I am going to show later from the ledger sheet the payments made.

The date of the next one, Order 44,094, was May 3, 1932, for 1 Tank Load 500 gallons Dow Hydrochloric Acid, Approximately 10 Baume, $17.50. One portion Arsenic Acid, $3.19, Labor Tank Service Transfer Charge $4.00, a total charge of $24.69. That shipment went to the Pure Oil Company? A. Yes, sir.

Q. Now, will you go through each of these other six order numbers and state—they were all shipped to the Pure Oil Company? A. Yes, sir.

Q. State in connection with each order the order number and the material shipped and the price charged for the material. A. Order 44793, invoice date May 5, 1932, called for 1 tank load 500 gallons Dow Hydrochloric Acid, approximately 10 degrees Baume, $17.50; 1 portion arsenic acid, $3.19; labor tank service transfer charge, $4.00. Total $24.69.

Order 46068, dated May 21, 1932, 1 tank load 500 gallons Dow Hydrochloric Acid approximately 10 baume, $17.50; one portion arsenic acid, $3.19; labor, tank service, transfer charge, $4.00, total $24.69.

Order 46377, invoice date May 25, 1932, 1 tank load 500 gallons of Dow Hydrochloric Acid approximately 10 baume, $17.50; 1 portion arsenic acid, $3.19; labor, tank service, transfer charge, $4.00; total $24.69.

Order 46567, invoice dated May 27, 1932, 1 tank load of Dow Hydrochloric Acid, 500 gallons, approximately 10 baume, $17.50; 1 portion arsenic acid, $3.19; labor, tank service, transfer charge, $4.00, total $24.69.

Order 46568, invoice May 28, 1932, 1 tank load, 500 gallons, Dow Hydrochloric Acid, approximately 10 baume $17.50, 1 portion arsenic acid $3.19, labor tank service transfer charges $4.00, total $24.69.

Order 46763, invoice date May 31, 1932, 1 tank load, 500 gallons, Dow Hydrochloric Acid, $17.50, one portion arsenic acid $3.19, labor tank service transfer charge $4.00, total $24.69.

The last seven orders were for the same amount of hydrochloric acid and each included one portion of arsenic acid and a charge for tank service, and the total charge in each one of them was the same amount, $24.69.

Referring to the second of these orders, which is dated March 11, 1932, I find no charge for arsenic, but in the third one I find charges for two portions of arsenic. The charge for these two portions of arsenic is twice the charge for one portion of arsenic included in each of the subsequent orders. The amount of hydrochloric acid in each of those ten invoices or orders was the same, 500 gallons.

Q. Now, I will ask you if you can account in any way for the fact that the second order included no charge for arsenic acid, and the third order included charges for two portions of arsenic acid, and each of the subsequent orders included charges for one portion of arsenic acid?

Mr. Lyon:

I object to that on the ground this witness can't testify

to anything except that he identifies these records. He doesn't know any more than the records, and the records speak for themselves.

The Court:

Witness, as you have only been assistant treasurer for a short time, I will ask you if as assistant secretary you did have access to these sheets and books? A. Yes, sir.

The Court:

During all the time you have been working there? A. Yes, sir.

The Court:

I will overrule the objection. Those familiar with accounts can read between the lines, where someone else can't, and I will let him interpret. A banker can tell you where a check went by his own system, while a stranger couldn't, at least with any ease, interpret it. All right witness. A. It is apparent that the charge for arsenic acid was omitted from the first shipping instruction and they were charged two portions on the following shipping instruction.

Q. And I will ask you whether or not the charge for the two portions in the third shipment and for no portion in the second shipment would be consistent with the fact that one portion was included with each of the second and third shipments?

Mr. Lyon:

I object to that as argument, and leading the witness.

The Court:

Pretty much that way. I will overrule the objection though and take the answer. A. I believe it was.

The Court:

I take it that his is more a line of reasoning and conclusion than what I thought was an interpretation of it. Isn't your line of reasoning quite largely based on the fact that at no time have you found so much of the inhibiting arsenic supplied and charged in any item as would be in the third, but that would be an unreasonable amount for them to use and put in from your custom and experience and the way it is done? A. That is right.

The Court:

And that seems to me with the other is the reason why there was no charge for it before.

Mr. Lyon:

Your Honor in your statement referred to the witness' experience in the way it is done. He hasn't any experience. He keeps the record.

The Court:

I agree my argument wasn't very good, but I can't get the answer. I didn't base it on what he would and I am glad he didn't follow my suggestion and didn't let me lead him, and it is very largely logic, but it seems to me it is a fair conclusion. I will let it stand and you can argue something else about it to me.

Mr. Owen:

I will ask that this bunch of ten orders to which the witness has referred be marked Plaintiff's Exhibit No. 231-A, B, C, D, E, and so forth.

(The documents above referred to were thereupon marked Plaintiff's Exhibits 231-A to 231-J, inclusive.)

The Court:

In other words, here the total, if I counted right, are nine charges, or was it some other number, or nine batches?

Mr. Owen:

Nine batches.

The Court:

Nine batches that went out. The first one they didn't charge for.

Mr. Owen:

There were ten batches with the first one.

The Court:

I didn't keep account of that. There were ten batches all told and all the books and everything show the first one they didn't charge for.

Mr. Owen:

That is right.

The Court:

Well, your nine uniform batches of inhibitor charged

for, if we spread even over there, but as it is there is the second one, no charge, and the third one would be what it is in all the others?

Mr. Owen:

That is right.

The Court:

And I would just naturally reach the conclusion that there was inhibitor in every one of the ten. The first one they didn't charge for and that they charged them for nine inhibitors, but they got two of them on one and none on another. All right.

I have here the accounts receivable record of the Pure Oil Company account. On Order 40327 is given Folio No. 3537, and that is posted on our accounts receivable, 3537 folio, dated March 14, a charge of $22.18, which corresponds with the charge on the order, without the arsenic. Order No. 42252 is given Folio No. 4516, was posted on April 5, for $29.68. That corresponds to the total of $29.68, and included the two portions of arsenic.

The Court:

It says "two portions."

Mr. Owen:

Yes.

Mr. Lyon:

This is a shipping order. It says ship two portions April 5.

Order 44094 is given Folio 5977, was posted on May 3rd, at $24.69. That agrees with the total on that order.

Order 44793 was given Folio 6121, posted on May the 5th, $24.69, and that agrees with the total of that order.

Order 46068 was given Folio 7105 and that was posted May 21st, for $24.69, and that agrees with the total of that order.

Order 46377 was given Folio 7323. That was posted May 25 for $24.69, and agrees with the total on that order. And that is true with all the rest of them.

Q. Does this ledger account show whether or not those items were paid for by the Pure Oil Company? A. Yes,

sir. When the checks come in, we make a check mark after the amount of the invoice, and those are all checked off. From time to time, the account is balanced.

Mr. Owen:

I will not offer these ledger sheets unless counsel wants them or the court wants to see them.

The Court:

I don't care to see them. I am satisfied.

CROSS EXAMINATION

The ledger sheet shows that the shipment of March 14th, which is the second shipment here referred to in the amount of $22.18, was paid March 31, before the date of the third shipment. It was actually paid by the Pure Oil Company before the date of the third shipment, and the amount paid for was just the amount of $22.18.

Q. And that is the amount your books showed was being charged for hydrochloric acid without any inhibitor in it without any arsenic in it, isn't that correct? A. I don't know whether there was any in it.

Q. I mean these records that you have produced here, these shipping records, you are selling hydrochloric acid at the rate of $14.00? A. Yes, sir.

Q. And the additional price was charged for arsenic above that rate? A. Yes, sir.

Q. And this record of this shipment of March 14, 1932 shows that the shipment was charged for at the rate of $14.00 and was paid for at that rate with no charge or no payment for arsenic? A. No, sir.

The Court:

And on all of those shipments one portion of the arsenic was charged at the uniform price each time? A. Yes, sir.

The Court:

And each time it was 500 gallons of the acid? A. Yes, sir.

The Court:

And the charge for that was uniform, too, as I recall it? A. Yes, sir.

The Court:

And the first one was never paid for because no charge was made; the second one was paid before the third one was delivered or charged for? A. Yes, sir.

The Court:

And they have all been paid for? A. Yes, sir.

The Court:

Well, we have all we can get from this witness.

Mr. Lyon.

I don't think this witness can help us any more. He would be guessing. We might as well guess as to ask him to guess.

SHERMAN W. PUTNAM,

a witness called by plaintiff, testified as follows:

DIRECT EXAMINATION

I reside at Midland, Michigan, and am assistant general sales manager for the Dow Chemical Company. I have worked for the Dow Chemical Company since 1919, with the exception of a short time in 1929. My duties for that company during the period around 1931 and 1932 were doing market development work on the new products. I

had something to do with the sale or attempted sale of hydrochloric acid by the Dow Chemical Company to be used in acidizing oil wells. That came within my jurisdiction after it was started. It did after the first treatments were made. It first came under my jurisdiction, so far as sales were concerned, as I recall it, late in the summer of 1932. The interest displayed by those interested in the production of oil when news of this treatment was spread around was beyond anything that we had really hoped for in that line.

Mr. Lyon:

Well, to save time, Mr. Owen, you have been over this in depositions.

Mr. Owen:

Yes.

Mr. Lyon:

And the company received quite a large number of letters of which you have produced copies. If you want to produce them and offer them in evidence we will waive proof, without your inquiring in detail and identifying them with this witness.

Mr. Owen:

All right.

Q. Just state briefly, Mr. Putnam, the character of the inquiries that came to your attention when this sale of this fifteen per cent hydrochloric acid was placed under your jurisdiction, as a new product or a new use? A. Why, the inquiries came from all types of people, from the very largest oil companies down to all the promoters that thought they could go out and buy up all the old oil wells and make millions off from them.

Q. In what form did those inquiries come? A. Mail, telegrams, telephone, and personal visits.

Q. You testified in the Williams Brothers case, and at that time produced a number of original letters, possibly telegrams, I don't know; certainly a lot of letters, which came to you in that connection. I will hand to you what was introduced in the Williams Brothers case as Exhibit

No. 3, and will ask you if those represent all of the letters that came to you in connection with the sale of hydrochloric acid for use in acidizing oil wells, during the period covered by those letters? A. No. These would only be just a very few representative letters of the type that came in.

The date of the first letter I have here is June 13, 1932, and the date of the last letter in that bunch is January 19, 1933. As I have stated, these are representative of a large number, a much larger number of letters that came to me during that period.

The Court:

You may go ahead. Why do you not have that whole book marked as an exhibit?

Mr. Owen:

I am going to have the whole book marked as an exhibit, but I would like to get into the record at this time the names of the concerns from whom these letters came, which constitute this exhibit.

To the witness: Will you read just the names, without going into the contents? A. Sarnia Oil & Gas Company, The Ohio Producing and Refining Company, Perkins Brothers, Inc., William E. Schwartz, Stanolind Oil & Gas Company, American Pipe & Steel Corporation, Ltd., The National Refining Company, Indian Territory Illuminating Oil Company.

The Court:

That was one of Mr. Doherty's companies, a subsidiary.

Mr. Owen:

Yes.

A. Union Oil Company of California, Empire Oil & Refining Company, Gulf Production Company, Shappell Oil Company, Hercules Powder Company, Continental Oil Company, Central Utilities Corporation, Crystal Oil Refining Corporation, Jo H. Cable, Petroleum Engineer, R. H. Brownlee Laboratory, The California Company, Union Crude Oil Corporation, Capital Drilling, Inc.,

Laughner Oil & Gas Co., Bradford Motor Works, Anaconda Kevin Oil Company, United States Department of Commerce, Bureau of Mines.

Q. What did they have to say? A. This is written from Shreveport, and reads:

"In the August 29, 1932, issue of the Oil Weekly page 57, I notice an account of the increasing of oil production from a limestone reservoir by the use of acid. I was very much interested in this article and am wondering if you have any literature regarding the procedure and the kind of acid and amounts used in these experiments.

"Any literature or material you have would be appreciated.

"Very truly yours,
"R. E. Heithecker,
"Petroleum Engineer."

The list continues: C. E. Daugherty & Company, John A. Kay, Petroleum geologist, Cambridge Gas Company and Harvard Gas Company, Amory Petroleum Corporation, Lone Star Gas Company, Texas Pacific Coal & Oil Company, Brown Tool Company, Inc., Shell Petroleum Corporation, Simms Oil Company, Texoma Natural Gas Company, Humble Oil & Refining Company, J. & J. Petroleum Corporation, Texas Gulf Coast Production Company, United States Department of Commerce, Bureau of Mines, from San Francisco, California.

Q. What do they say? A. That is December 12, 1932:

"Gentlemen:

"I am interested in your chemical processes to increase oil production and wish you will kindly send me your booklet entitled 'How to Increase Oil Production.'

Signed "H. C. Miller,
Senior Petroleum Engineer.".

William C. McBride, Incorporated, and the Silurian Oil Company, The Empire Companies, J. S. Cosden, Incorporated, B. V. Von Vitanyi.

Q. Where did that come from? A. Germany.

Q. Will you read that?

"From your advertisement in the 'Oil Weekly' I read about the development of a new chemical process for the purpose of increasing oil production.

"Being the representative of the Ingersoll-Rand Company, 11 Broadway, New York, for Germany, I am greatly interested in the new process developed by you in view of my close connections to the German oil fields around Hanover.

"Please forward your booklet describing the new method and its adaptability to different oil formations. In case you think the method applicable to European oil fields I certainly would like to join your sales organization in some form.

"Referring you to Messrs. Ingersoll-Rand Company for any information you may desire about my person, I hope to have an early answer from you.

Signed "B. V. Vitanyi."

Q. What is the date of that letter? A. That is December 15, 1932.

Q. Then go on and give the names of the other parties from whom you received letters? A. R. B. Laing, Gypsy Oil Company.

Q. Will you read the one from the Gypsy Oil Company? That is the last one, I believe. A. Yes, sir. It is dated January 19, 1933, and reads:

"We have noted with interest the result of acid treatment as applied to oil wells, and the rapid spread of this method of treatment throughout the Mid-continent area.

"We have in mind the possibility of treating certain of our wells in the State of Kansas, and in this connection would like to know whether or not your company will be prepared to service wells in that area within the near future. If you have a specific plan formulated, we would like to know the date on which your service will be available.

Signed "G. G. Sanderson,

"General Superintendent."

Mr. Owen:

These letters will be offered as one exhibit, No. 13.

(The letters above referred to were thereupon marked PX-13.)

To the best of my knowledge the article in the Midland, Michigan, Republican of June 9, 1932, under the heading "Treat Wells by Dow Process to Jump Production," was the first newspaper or trade journal publicity that was given this treatment. I recall having seen the article in the Oil Weekly of August 29, 1932—page 57—at about the time it was published.

Q. I also show you a photostatic copy of another issue of the Oil Weekly, page 103, but there is no date on it. I cannot tell what the date was. Do you recall about when that was published? A. Why, this came out, I believe, in late '32.

Mr. Owen:

Mr. Conner just told me it is dated November 14, 1932. I will write that date on with the understanding if it is incorrect it may be corrected.

These three photostatic copies of publications will be offered as Plaintiff's Exhibit 14, and I wish to read into the record the first paragraph of the article in the Midland Republican for June 9, 1932.

The Court:

I will admit them as one exhibit.

Mr. Owen:

The first paragraph of the Midland Republican reads as follows: "A new process of injecting acid into oil wells, which is supposed to increase the porosity of the oil bearing sand and result in a heavier flow of oil from wells which have nearly stopped producing, was announced this week by Dow officials. Oil men are showing a keen interest in the process, which they believe would revive old wells, especially since it has been said to produce as much as ten times the original flow in one stripper."

The article in the Oil Weekly for August 29, 1932, states:

"Walter L. McClanahan Inc.'s Schaffer 1, Midland County, Greendale Township, SW. SW. SW. Section 12, which was drilled into the Dundee limestone about six weeks ago with an initial production of 125 barrels was boosted to 1070 barrels a day this week when treated with acid, a special solution developed by Dow Chemical Company of Midland, Michigan. The well flowed 750 barrels the second 24 hours after treatment and after five days was producing better than 500 barrels a day."

I will read also a part of the article which appeared in the Oil Weekly for November 14th, 1932, under the heading "Acid Makes Good Producer Out of Abandoned Well."

"Mt. Pleasant, Mich.—T. K. Buzard's Mahon 1, Isabella County, Isabella Township, Section 24, a well plugged as dry several months ago, flowed 368 barrels of oil in 21 hours after being cleaned out and run with a special acid limestone solvent solution. The well made 200 barrels the second 24 hours and is continuing to flow from 100 to 175 barrels a day.

"This is the first instance in Michigan at least where an abandoned well has been re-worked with commercial success.

"In the east field of the Central Michigan proven area, Braden-Saunders' Stapleton 3, Midland County, Greendale Township, Section 13, completed in September for 210 barrels a day, was boosted to 1700 barrels a day this week when treated with the acid limestone solvent."

The Dowell Company, and previously the Dow Company, was in the business of acidizing wells during the year 1932, and they began to advertise that service in trade publications in the fall of 1932, after Dowell Incorporated was organized.

CROSS EXAMINATION

By Mr. Lyon:

Q. Mr. Putnam, what prompted these letters and inquiries from the trade which have been referred to here, an announcement by the Dow Company in some form that they had a new process? A. As I recall it it was more word of mouth than anything else.

Q. Didn't you announce in these statements that appeared in the newspapers that you had a new process? A. Well, so far as we were concerned, we did not attempt to go out and get publicity early in the oil treating business. We announced to the trade that we had a new process, at some time during the year. I wouldn't know exactly when that was. As to what we announced regarding the new feature of the process, I would want to refresh my memory by looking at some of the things we wrote up at that time. I don't remember whether or not we told the public that the thing that was new about our process was that we were adding an inhibitor to the acid, and that was the only thing that was new. As to whether or not we announced to the public that we had a new process employing a new acid and didn't even tell the public what the acid was, I would have to go back and see how we handled that. That was nearly ten years ago.

I testified before Judge Kennamer in the Williams Brothers case.

Mr. Lyon:

Judge McDermott, in stating the grounds on which he reverses the lower court, why he holds this invention says:

"Patentee expended substantial sums to demonstrate the utility of the invention before applying for the patent."

Now, as appears at page 68 of the printed record on appeal, you testified as follows before Judge Kennamer, did you not:

"I can give you a part of the cost of the plaintiff in

its early development of the process in connection with the research laboratories, advertising, etc."

And you gave there testimony on which Judge McDermott based that finding. You understand that. A. Yes.

Q. You do not any longer contend that that testimony was correct, do you? A. If I so testified in the Williams Brothers case, it was correct to the best of my knowledge at that time, but it has been nearly ten years and I don't recall all the details.

Q. Well, you know, do you not, that money was not spent by the Dow Company in connection with experimenting with this inhibitor, at all, but was expended on some earlier work they had done on acidizing wells which had nothing to do with the Grebe and Sanford patent? A. Why, I couldn't answer that because you are getting into details now I am not familiar with.

Q. Well, you do not care now, you are not prepared now to repeat the testimony which you gave before Judge Kennamer and which was accepted in Judge McDermott's opinion as one of the bases on which he placed his opinion, you don't care to repeat that, to-wit, that some $11,000 had been spent, and so forth, on this invention before—not $11,000, but a very large sum had been spent on this invention before the patent was applied for on experimental work? A. I am very glad to repeat my testimony of that time if my memory may be refreshed.

Q. Now, had the Dow Company expended substantial sums to demonstrate the utility of the invention before the patent was applied for in June, 1932, and by the invention I refer to the addition of the inhibitor to the acid? A. If I so testified at that time, that was correct.

Q. I am asking you now to testify, had they, to your knowledge? A. Well, I don't recall now as to just what the dates, and so forth, were on that.

CALVIN A. CAMPBELL,

a witness called by plaintiff, testified as follows:

DIRECT EXAMINATION

I live at Midland, Michigan, and am an attorney with the Dow Chemical Company. Head of their legal staff and one of the counsel in this case. I am not a patent attorney and look after the patent work only in a general way.

I have access to the licenses which are granted by the Dow Chemical Company. All licenses with respect, particularly, to these acidizing patents go through my office and through me personally. I have them with me.

By Mr. Owen:

Q. Will you go through them one at a time and state when each one was granted, and to whom, and if you can I would like to have you give them chronologically?

The Court:

You said something about licenses. You mean licenses under just the four patents in suit?

Mr. Owen:

No. They include the four patents in suit, and a number of others.

The Court:

You are not asking for all the licenses that they hold.

Mr. Owen:

Only the ones that include the patents in suit, licenses under the patents in suit, but those licenses—

The Court (interposing):

There are only four patents in suit?

Mr. Owen:

Yes, Your Honor.

The Court:

Then, all you are asking for is the licenses they hold under these four patents, aren't you?

Mr. Owen:

I am asking for the licenses that the Dow Chemical Company has granted to others under these patents.

A. Mr. Owen, in answering that question I assume you want the license agreements that have been granted but are not now in existence, is that correct?

Q. I would like a complete list of them chronologically whether or not they are now in existence? A. The first license agreement was between the Dow Chemical Company and Dowell Incorporated and was entered into on November 20, 1932. It has been superseded by a new agreement dated September 9, 1936, which is now in existence.

The next agreement is with the Pure Oil Company. The date of the first agreement between Pure Oil Company and Dow Chemical was January 1st, 1932, and that was superseded by a new agreement dated June 30th, 1934, and that agreement with Pure Oil Company dated June 30th, 1934, is still in existence. And the last dated agreement with Dowell is still in existence.

There was an agreement dated March 12, 1934, between the Texas Treating Company, a co-partnership of Dallas, Texas, and Dowell Incorporated relating to patent 1,877,504, which is not now in existence,—a license agreement under that.

The Court:

Has the Dowell Incorporated got the right to grant sub-licenses A. The Dowell Incorporated under its existing agreement, which is the one dated September 9, 1936, has the right to sub-license its customers under the patents mentioned in the agreement, to use the patents only in connection with materials purchased by customers from Dowell or a similar quantity purchased elsewhere. So, the agreement that Dowell made with the Texas Treating Company apparently was under a prior agreement which is not now in effect. At the present time Dowell has no right as such to sub-license under the patents other than what I have just stated to you.

The Court:

You mean Dowell Incorporated has no right? A. Dowell Incorporated, that is correct. Dowell Incorporated is Dowell. That is the way we generally refer to them.

The Court:

And Dow Chemical still retains the right to license others if they want to? A. That is exactly right. The agreements I am about to read are the license agreements that Dow Chemical has made with others.

The Court:

(Interposing): That is what I thought. That is what confused me here. This third one you mentioned is a sub-license. They are sub something from Dowell? A. That is correct. That agreement is no longer in effect, however.

The next is an agreement dated August 9, 1934, between the Stanolind Oil & Gas Company, and Dowell, Incorporated, and that falls in the same category as the previous exhibit that I mentioned with the Texas Treating Company and Dowell. That agreement is not now in existence, and it expired on August 9, 1939. It was a sub-contract made by Dowell.

The next agreement is between Dow Chemical Company and Robert J. Quinlan, dated December 24, 1936, and is in existence at the present time.

The Court

That makes three I have that are still in existence. A. Yes, that is correct. The Pure Oil Company, Dowell and Robert J. Quinlan.

The next agreement is between Dow Chemical Company and the Morgan Well Treating Corporation, dated January 1, 1937, and that agreement was cancelled, or, rather, it expired as of January 1, 1940.

The next agreement is between the Dow Chemical Company and the Big West Oil Company, of Montana, dated November 15, 1937; and it expired on November 15, 1939.

The next agreement is between Dow Chemical Company and Warren Hough, of Shelby, Montana, dated June 10, 1938, and that agreement is in existence.

The next agreement is dated August 31, 1938, between the Ainsworth Well Treating Service and Dow Chemical Company, and that agreement was cancelled as of January 1, 1940.

The next agreement is betweeen Dow Chemical Company and Pacific Cementing Company, dated September 2, 1938, and that was cancelled as of October 31, 1940.

The next agreement is between Dow Chemical Company and A. G. Chiles, of Hillsboro, Texas, dated May 23, 1939, and that agreement is in existence.

The next agreement is between the Dow Chemical Company and James G. Vander Grift, of Spencer, West Virginia, dated June 30, 1939, and that agreement is in existence.

I also have three agreements which are in existence, which were entered into in 1940. The first agreement is between Dow Chemical Company and Lane & Bowler Incorporated, dated April 24, 1940. The next one is between Dow Chemical Company and Charles Theo. Eline, dated May 28, 1940, and the next and last agreement is between Dow Chemical and International Cementers Inc., dated December 4, 1940.

I forgot to mention that there is one other agreement between Dow Chemical and Dowell Sociedad Anonima dated October 11, 1936, covering license rights in Mexico, a licensee and wholly owned subsidiary of Dow Chemical Company. That is still in existence. So, as a recapitulation, I have got nine existing agreements.

The Court:

Ten, counting this last one. Ten counting Dowell Incorporated, unless I have made a mistake. A. That is correct, Your Honor. I did not include Pure Oil Company. So including Pure Oil Company there are ten.

The Court:

Six have been issued and cancelled or expired.

CROSS EXAMINATION

By Mr. Lyon:

Q. In the Pure Oil Company agreement which is in effect between Dow Chemical Company and the Pure Oil Company, there is a provision to the effect that "Dow shall pay unto Pure a royalty of $5.00 for each and every well which shall be treated by Dow, its subsidiaries, sublicensees, agents and representatives, provided, however, that the royalty shall not apply to any wells treated by Pure." That is correct, isn't it? A. That is the way the agreement reads, yes, sir.

Q. As a matter of fact, the agreement between Dow and Pure was reached following a dispute between Pure and Dow as to the rights to the acidizing invention, was it not? A. This agreement that you just read from states that the contract of June 30, 1934, superseded and terminated the agreement dated January 31st, 1933.

Q. Well, the prior agreement of January, 1933, contained a provision that Dow shall pay Pure in the manner hereinafter specified a royalty of $5.00 for each and every well which will be treated by Dow, its subsidiary, and so forth, did it not, until the royalties so paid shall amount to $15,000? A. That is correct.

Q. There is no such limitation on the new agreement? A. You mean about the maximum amount?

Q. Yes. The present effective agreement. A. That is correct; yes.

Q. Well, now, these two agreements, one replaces the other and they are the only two agreements between Dow and Pure on this subject? A. There is really only one agreement between Dow and Pure because the latter one superseded the former one.

Q. Yes. Well, now, the agreement was made between Pure and Dow following a dispute between the two companies as to the rights of the acidizing invention, was it not? A. I didn't hear the latter part of that.

Q. Would you just read it.

The Court:

You refer now to the first agreement or the continuing agreement?

Mr. Lyon:

Oh, to the first agreement.

(The pending question was read by the reporter.) A. I know nothing of that. It was before my time, and I don't know whether it was true or not, of my own knowledge.

Q. When did you go with the Dow Company, Mr. Campbell? A. June, '35.

Q. June of 1935. Then you are not familiar or never heard of the letter addressed to the Pure Oil Company on November 1st, 1922—or 1932, by Mr. Willard Dow, and the Pure Oil Company's reply dated December 1st, 1932? A. I think I have seen that letter, and that is all. I know nothing about it.

Q. Could you identify those letters as letters in the company files? A. I cannot identify those letters, no.

Q. Did you negotiate either of these agreements between the Pure Oil Company and the Dow Chemical Company? A. No, sir.

Witness:

I referred to an agreement with the International Cementing Company, either the Dow Chemical Company or Dowell owns an interest in the International Cementing Company, or International Cementers, Inc. I am not sure which one it is. It is either Dow Chemical or Dowell that is a stockholder in that company, and I think it is Dowell. I am not sure what percentage. They are a substantial stockholder. One of the two, and I am not sure which it is. They were one of the incorporators and organizers of the company.

The only ones of these nine existing licensees outside of the Pure Oil Company in which either Dow Chemical or the Dowell have an interest are Dowell, Incorporated, Dowell Sociedad Anonima and International Cementers. That leaves six license agreements outstanding which are

held by concerns in which neither Dow nor Dowell hold any interest.

The Court:

(Interposing): What about Pure Oil?

Mr. Lyon:

That is excluded, your Honor. We have excluded that from this consideration.

So far as I know all those six concerns are actually operating under their license agreements and paying royalties at this time. The Accounting Department would know better as to whether they are actually paying royalties. They are actually actively employing the processes at this time. I know that of my own knowledge in each case.

These license agreements are not limited to the patents involved in this suit. They include other patents, too.

Q. I would like to know what patents those licenses are issued under. A. A typical example of a license is the A. G. Chiles license in which there are licensed fifteen patents, of which Dow Chemical is the owner. The licensee has also been granted license rights under two patents which Dow Chemical Company has a right to grant licenses.

Q. Does that include the Carr patent of the Pure Oil Company? A. That includes the two patents I am talking about which Dow Chemical has a right to grant sublicenses, Patent 1,891,667 and Patent 2,018,199, the first inventor being Carr and the second patent being Carr and Humphrey, inventors.

Q. Are the four patents involved in this suit of the Dow Company listed in these licenses, these six licenses, among those fifteen? A. Included in the fifteen patents in the Chiles license are the following four patents: 1,877,504, 1,916,122, 1,998,756, and 2,024,718, which I have been informed are the patents in suit.

Q. The licenses also cover eleven other issued patents by number? A. That is correct.

Q. Can you give us the numbers of those eleven other patents? A. Referring to the Chiles license, these are numbers 1,498,045; 1,911,446; 1,963,072; 1,989,479; 2,048,-

362; 2,503,285; 2,125,429; 2,127,662; 2,146,732; 2,146,754, and 2,152,306.

By Mr. Lyon:

Q. Continuing: Do you know whether or not those are all patents on various inventions relating to the acidizing of wells? A. That is correct. That is my understanding of them.

REDIRECT EXAMINATION

By Mr. Owen:

Q. You spoke of having rights to grant licenses under a Carr patent and under a Carr and Humphrey patent. And you also spoke of paying to the Pure Oil Company $5.00 a well royalty. Do those two things have any connection? A. The agreement with the Pure Oil Company, dated June 30, 1934, was a grant by Dow to Pure Oil Company of a non-exclusive license under 1,877,504. There was a reciprocal grant from Pure to Dow, a non-exclusive license with the right to sub-license others, under patent 1,891,667, and any other patents which Pure may acquire, own or control during the existence of this agreement and relating to the acid treatment of oil or gas wells for the full term or terms of any such patents.

The second sentence says: "Dow shall pay unto Pure a royalty of $5.00 for each and every well which shall be treated by Dow, its subsidiaries, sub-licensees, agents or representatives after the execution of this contract, provided, however, that such royalty shall not apply to any well treated by Pure."

RECROSS EXAMINATION

By Mr. Lyon:

Q. Under that agreement the Dow Company actually has paid a royalty to the Pure Oil Company on all acidizing jobs performed by the Dowell Company or Dow, and not simply on those performed using the Carr invention, isn't

that correct? A. That statement of yours is correct, with this proviso—that there was an amendment to that agreement, dated October 19, 1938, between Dow Chemical and Pure, reading as follows: "The royalty of $5.00 for each and every well which shall be treated by Dow, its subsidiaries, sub-licensees, agents or representatives shall apply only on acid treatments where the acid is used to attack a productive formation.

Q. Yes. In other words, the intent of the agreement as shown by what has been done in performing it is that Dow shall pay to Pure $5.00 on each acidizing job where the acidizing is to penetrate the formation. The payment of royalties is not limited to those jobs where Dow has employed the inventions of the Carr patents. A. That is correct.

CHARLES PENHALIGEN,

a witness called by plaintiff, testified as follows:

DIRECT EXAMINATION

I live at Midland, Michigan, and am Treasurer of Dowell, Incorporated. I have been associated with that company over five years. My duties at first were as an accountant. On January, 29, 1937, I was elected Assistant Secretary and Auditor. On June 28, 1937, I was elected Assistant Treasurer. On June 5, 1940, I was made treas-

urer. The records of Dowell, Incorporated, are under my charge, or accessible to me.

Mr. Lyon:

We will concede, your Honor, that they have proper records, and that they will show royalties received from jobs done, and we will concede the competency of this witness to prepare a summary from the records, and if he produces a summary and says that it is correct to the best of his knowledge and belief, we will accept that without any further proof.

The Witness:

I have prepared a summary showing the growth of the Dowell business, both with respect to personnel and stations, as well as with respect to the locations in which the company operates, and the number of treatments made, which I produce.

Mr. Owen:

This enlarged chart, your Honor, which we will offer as PX-94, contains the data which this witness has prepared. I hand the court a reduced photostatic copy of that chart.

(The chart was thereupon marked PX-94.)

The Witness:

These are the Dowell, Incorporated, statistics for the period November 10, 1932, to December 31, 1940, inclusive, by years, and this reports the personnel, treating stations, pump trucks, compressor trucks, tank transports, tank trailers, pick-ups and passenger cars; the number of well treatments, and the number of states in which Dowell operated by years. The number of well treatments indicated on this chart do not include treatments made by licensees of Dowell, or of the Dow Company. Those are treatments that were made by Dowell Inc.

The portion of the chart which indicates the states in which Dowell operates indicates the order in which Dowell or Dow operated in these respective states. Michigan was the first, then Ohio and Kentucky. Those stations were all opened in 1932. Under 1933 we have those three states repeated and in addition Kansas, Louisiana, Oklahoma and

Texas, which means that stations in those four states were opened during 1933. That explanation follows all down through until in 1940 Dowell is operating in sixteen states. Dowell also operates outside of the United States, in Alberta, Canada. I think that Dowell operated in Ontario, Canada, starting in 1932 and started operations in Alberta, Canada, in 1937. The figures indicating the number of well treatments include those made in Ontario and Alberta.

We also have records showing the number of treatments made by licensees of Dow Chemical or of Dowell. I could prepare from those records a statement showing the number of treatments made by each of the different licensees by years, on which treatments those licensees paid royalties to Dow Chemical Company, and will do so. That statement will show the number of treatments by each licensee for each year during the period for which they have been licensed, and the amount of royalty paid by each licensee each year.

Mr. Owen:

I will ask the witness whether or not he knows the fact regarding the use of inhibited acid in the well treatments which he has listed in PX-94. A. It is my understanding that these wells were treated with inhibited hydrochloric acid.

Q. Will you refer to some invoices showing the use of the surface tension reducing agent? A. Yes, sir. I have a copy of a Dowell Incorporated invoice, dated July 7, 1934, billing the Continental Oil Company, of Borger, Texas, for one Dowell treatment, consisting of 875 gallons of Dowell X, and 150 gallons of XF. The X is 15 per cent inhibited hydrochloric acid, and F is surface tension agent, the reducing agent. When the letters "XF" are used together it indicates a combination of 15 per cent inhibited hydrochloric acid, and the surface tension reducing agent.

Mr. Lyon:

Is that the earliest date of an order that you could find showing the use of a surface tension reducing agent? A. I would not say it is the earliest, but it is one of the earliest.

The Court: What about the jelly seal? A. Well, jelly seal, I don't think was used until 1935, latter part of 1935.

Mr. Owen: Can you produce evidence or invoices showing an early instance when each of these different services was used? A. Yes, sir. I have invoice instructions here, dated November 23, 1932, on which we issued an invoice to the G. Lee P. Company, Midland, Michigan, for 1,000 gallons of Dowell X and 25 gallons Dowell blanket. It is my understanding that this was the calcium chloride blanket. I have here a warehouse shipment paper, which is instructions to the Invoice Department, dated December 1, 1932, to invoice H. P. Leeper for one Dowell service treatment, consisting of 500 gallons of Dowell X and 55 gallons of Dowell blanket.

I also have a copy of a Dowell Incorporated sales invoice, dated March 12, 1936, billing the Stanolind Oil & Gas Company, Tulsa, Oklahoma, for Dowell jelly seal, base service charge of $25.00 and Dowell jelly seal used in addition, 169 gallons, at 50c a gallon, $84.50, and this invoice is sup-

CROSS EXAMINATION

By Mr. Lyon:

Q. I believe you have some printed schedule of the different compounds or agents that are employed by your company in acidizing the wells, that is the agents that are added to the acids, by a series of letters? A. Yes, sir.

Q. Will you just read me that schedule? I mean, what different letters are employed and what each one of the letters stands for?

Mr. Owen:

I object to that, Your Honor, if it refers to materials other than those involved in the practice of the inventions of the four patents in suit. I can't see what relevancy it can have.

Mr. Lyon:

I want to say, Your Honor, that these treatments which are involved in this summary, Exhibit 94, include a lot of different features that are covered by patents which are not involved in this suit, so as to show that those treatments are in part based on other things that are not involved in this suit.

The Court:

I don't see any way of avoiding that. You show very properly the growth by the use of these patents but your own table shows that other patents are used along with these. Now, right as I set here right now, you see, I have no way of knowing how much that growth is due to the patents in suit, and each one of the patents in suit, or as between the patents in suit and this larger number of patents that were included there than are in suit.

Mr. Owen:

Yes; that is true.

The Court:

Now, the same chart could be used almost in a suit based on some of those other patents not in suit, you see, and I am confronted with a situation where I don't see how to avoid that inquiry being made as to what this is.

By Mr. Owen:

Possibly this would avoid the difficulty that I am in. As I understand it, our client is not anxious to disclose its code numbers for different treatments to its competitor, the defendant in this case. I will ask the witness to state what information he would be able to give on the subject of what different ingredients were used in these treatments which are indicated on PX-94 from an examination of the invoices or other records which you have under your control without disclosing the code number which is used by Dowell Incorporated to designate these different ingredients. A. The customer receives the information as to XX and jelly seal and W's and F's, but I don't know what the chemicals are that are used in these,—the names of these chemicals. I am not a chemist.

Mr. Lyon:

Let me ask him this question. I don't think you will object to this. Under these code numbers can you tell us about how many different things there are that are added to this acid or used in this acidizing? Do you have a schedule there of the code numbers and each code number is a different thing? If you just tell us how many of those there are, that will be a start? A. Well, I have before me a Dowell Incorporated acidizing service price schedule.

Q. And how many different items are there as indicated by different code numbers there? A. Well, it reports Dowell X, XF, XG, XR, XW and XX.

The Court:

Six.

Mr. Lyon:

Q. And which of them relate to the four patents in suit? A. I don't know what the patents are.

Q. You looked at something else. A. I referred to this book here (indicating) X, XF, XG—

Mr. Lyon:

How many are on there? A. Seven.

Q. Well, you might give all of those seven. A. Dowell X is inhibited hydrochloric solution. Dowell F is

a surface tension reducing agent for use in tight or low pressure wells. Dowell G, foaming agent for use in limestone removal. Dowell W, agent which imparts emulsion prevention and wetting properties to the acid. Dowell XX, intensifying agents for use in Dolomite formations. Dowell XR, retarding agents for use in fast action limestone formations. Dowell XW, mixture of highly active acids capable of dissolving Bentonite types of mud.

Q. Now, are you able to state whether or not the total well treatments indicated on Plaintiff's Exhibit 94 contained inhibited acid? A. Yes, sir.

Q. Or rather involve the use of inhibited acid? A. Yes, sir.

The Court:

All of them? A. Yes, sir.

The Court:

I am suggesting a chart that would show wells treated with inhibited acid and nothing else. I don't know what it would show. It certainly wouldn't show the growth here, because you have got those wells as well as these using the new fangled stuff. A. True.

By Mr. Lyon:

Q. I just want the court to see the form of the Dowell invoices. This is a typical form, isn't it? (Indicating.) A. Yes, sir.

Mr. Lyon:

This is an invoice dated 3/16/36 to the Stanolin Oil and Gas Company, and the following description and prices appear on the invoice:

"Acid L. L. Austin No. 36 Well Section 36 12 16 Ellis County Kansas with 1,000 gallons of Dowell X and other materials, unit price $225. Additional Dowell X used 2,000 gallons at 20 cents per gallon, unit price $400. Additional for using Dowell jelly seal, base service charge $25. Dowell jelly seal used, 150 gallons at 50 cents per gallon, $75. Total $725. Less 20 per cent contract discount, $145. Amount $580."

Q. Now, where these different items, of which you have given us the code numbers, were used in the service or in the treatment, they would be identified and itemized charges for those would appear, for those individual items appearing on the invoice, would there not? A. Yes, sir.

Q. Do these well treatments that are tabulated in the summary, Exhibit 94, include anything except acidizing jobs? A. No, sir.

Q. Do you know whether these well treatments up here that are summarized on Exhibit 94 include mud treatment jobs that have been done by your company? A. Well, if we used inhibited hydrochloric acid, it is included. I don't know what the technique is on the mud acid. I don't know whether they use hydrochloric acid or some other acid. I do not know what is meant by "mudding off" a well. I know we have a mud acid service. I would have to go back to the records to tell whether or not that includes hydrochloric acid.

These figures on Exhibit 94 include jobs in California. I don't know that the only service that our company performs in California is this mud dissolving, and that there is no acidizing of formations in California. At the present time we are not in California. We were in '40. I don't know that we never did acidize formations in California. I don't know one way or the other. These figures may include services performed by our company which are not acidizing formations, as far as I know. Those figures include sales invoices we have on hand that indicate we acidized the wells, using 15%—or use inhibited hydrochloric acid. Every one of these treatments included in the summary, Exhibit 94, did employ hydrochloric acid. I don't know what hydrochloric acid was employed in the jobs in California that are indicated on Exhibit 94. I don't know of the exact application. I don't know whether they were for treating formations to increase the productivity. I do know that we have a mud service operation. As to whether the jobs in California were the mud service operation or the treatment of formations, it would be necessary for me to review our records.

WILLIAM F. BROWN,

a witness called by plaintiff, testified as follows:

DIRECT EXAMINATION

I live at Mt. Pleasant, Michigan, and am a consulting geologist. I received a Bachelor of Science degree from the University of Michigan in 1925 and spent a year on graduate work at the University of Wisconsin in 1926. After finishing college I worked for the Michigan State Conservation Department, The Pure Oil Company and the Cities Service Company, and since 1931 have been a consulting geologist in Michigan.

Referring to the article in the August 29, 1932, issue of the "Oil Weekly" (PX-14) relating to the Walter L. McClanahan Inc.'s Schaeffer No. 1 oil well located in Midland County, Michigan, I have examined the State production records for this well at the office of the Michigan Tax Commission for the period from July 14, 1932, the completion date of the well, to June, 1936, the date when the well was abandoned. These records are sworn statements made by the oil operator to the State of Michigan Tax Commission and are open to the inspection of the public and show that this well was completed July 14, 1932, during which month it produced a daily average of 75 barrels of oil. After being acidized, it had a daily average production of 334 barrels for August, 374 barrels for September and 234 barrels for October of 1932.

I also examined the records of the Michigan State Tax Commission and Michigan Department of Conservation concerning T. K. Buzzard's Mahon No. 1 well, referred to in the November 14, 1932, issue of the Oil Weekly (PX-14). These records showed that this well produced 381 barrels of oil in January, 1932, 538 barrels in February, and 58 barrels in March, was plugged and abandoned on March 12, 1932; reopened in October, 1932, and treated with acid, and in November, 1932, it produced 2,017 barrels of oil, and in December 2,020 barrels of oil. The well was finally plugged and abandoned in 1936.

I examined the records of the geological division of the Michigan State Conservation Department concerning the oil wells in the Greendale Oil Field, Midland County, Michigan, and from them made a compilation covering the years 1932 to 1940, showing each year the number of oil wells completed, the number of dry holes, the number of wells shot (dynamited) at completion of the well drilling, and the number of wells treated with acid at completion. This compilation shows that from 1928 to 1932 the number of wells drilled in this oil field increased, and that from 1932 to 1940 the number of new wells declined. The top number of new wells completed in any year was 98 in 1932. During that year seven dry holes were drilled, three wells were shot at completion and eight were acidized. The compilation shows a decrease in the number of wells shot at completion and an increase in the number of wells acidized at completion.

The compilation was offered as PX-99, and is as follows:

COMPLETION DATA GREENDALE OIL FIELD
Greendale Twp., Midland County, Michigan

Year	Oil Wells Completed	Dry Holes	Wells Shot at completion	Wells acidized at completion date
1928	3	0	1	0
1929	11	2	0	0
1930	17	0	0	0
1931	26	3	1	0
1932	98	7	3	8
1933	53	8	0	4
1934	19	1	0	4
1935	14	3	0	11
1936	13	2	0	13
1937	6	3	0	6
1938	0	0	0	0
1939	1	0	0	1
1940	1	0	0	1

CROSS EXAMINATION

By Mr. Lyon:

Q. This PX-14 and the data you presented a moment ago refer to the well known as T. K. Buzard's Mahon 1 Isabella County, Isabella Township, Section 24? A. Yes.

Q. You know that well? A. Yes.

Q. Do you know who acidized it? A. No.

Q. Do you know whether Dow or Dowell acidized it? A. No.

Q. I show you acidizing order to the Halliburton Oil Well Cementing Company, from Petroleum Investors, Inc. with respect to Knight Well No. 2, Section 16, Township 18 N, Range 1 East, dated 4-24-39, signed by William F. Brown. Is that your signature? A. It is.

Q. By what authority did you sign that order on behalf of Petroleum Investors, Inc.? Were you connected with Petroleum Investors, Inc., at that time? A. I have done considerable consultiing work for them, yes.

Q. I have asked you the question, were you employed by them at that time? A. Not as a member of the firm.

Q. What authority did you have to sign an order, an acidizing order to the Halliburton Company on behalf of Petroleum Investors, Inc., at that time? A. I asked them for a letter giving me permission to acidize that well, and to be present and observe, and take samples on the well at the time it was acidized.

Q. Why didn't you sign the order in your own name, on behalf of yourself, if you were doing the work—if you were having the work done for yourself? A. It wasn't my well.

Q. I show you a letter on the stationery of William F. Brown, Petroleum Geologist, Mt. Pleasant, Michigan, dated April 19, 1939, addressed to the Petroleum Investors, Inc., and Doherty & Markay, Inc., Olympia Building, Mt. Pleasant, Michigan.

(Reading): "Gentlemen: Since I am desirous of ob-

taining certain acid treatment information for a client, and since you are desirous of having a well treated, I agree to pay to you the full charges made by the acid treating company for the treatment of the Knight No. 2 well, located in the SW¼ of Section 16, Hay Township, Gladwin County, Michigan.

"The conditions which I require are:

"That I choose either Dowell or Halliburton Company to do the work, specify the type of treatment, and be present during the full operations of treatment.

"Also, I shall require average daily production figures for ten days before and ten days after treatment.

"If the above arrangement will be satisfactory to you, please denote your approval below.

"Very truly yours,

"William F. Brown."

Is that your signature? A. Yes, sir, it is.

Q. Did you send that letter to the Petroleum Investors, Inc., under the date of April 19, 1939? A. I did.

Q. Who was the client referred to in this letter for whom you desired the information? A. The Dow Chemical Company.

Q. Were you authorized by the Dow Chemical Company to enter into this agreement with Petroleum Investors, Inc., whereby you could require that the Halliburton Company acidize this well of the Petroleum Investors, Inc.? A. They asked me to get certain information and to do it in the way that I wanted to.

Q. Did you reimburse Petroleum Investors, Inc., for the Halliburton Company charges for that job? A. I did.

Q. Was that money paid to you, supplied to you by Dow? A. It was.

Q. Well, now, were you present at the acidizing of that well by the Halliburton Company? A. I was.

Q. Did you pose as an employee of the Petroleum Investors, Inc.? A. I did not. It was not necessary to do so. I was merely present at the acid work.

Q. In what capacity did you advise the Halliburton representative that you were attending that job—in any? A. I don't believe they asked.

Q. You signed this order? A. If they had asked me, I would probably have said that I was doing it for myself.

Q. Where were you when you signed this order? A. At the well.

Q. You were at the well? A. Yes.

Q. How did they come to ask you to sign the order? A. Because I ordered the acid. I was there at the complete treatment, and supervised the treatment from beginning to end.

Q. You do not deny that you posed as a representative of Petroleum Investors, Inc., do you? A. No.

Q. You did not advise the Halliburton Company that you were representing the Dow Company? A. I did not.

Q. Did you specify any of the conditions under which the well should be treated? A. I did.

Q. Did you specify that inhibited acid be used? A. I did not.

Q. What other directions did you give? A. The main directions were to put 1500 gallons of acid in the well, and to put a blanket at the bottom of the tube, and to flush it.

Q. What kind of a blanket? A. Blanket seal.

Q. What kind? A. I didn't specify. They were to use their own blanket. Then the tubing was to be flushed with oil. That is about all the instructions I gave them. Otherwise, they were to use their own regular methods of acid treatment.

Q. Did you give them these instructions in writing? A. No.

Q. Did you specify that oil would be pumped into the well first, before the acid? A. Well, we were trying to get circulation from the tanks.

Q. Did you specify? A. Did I specify?

Q. Yes? A. I don't remember whether I did or not. I doubt it.

Q. Do you remember that the oil was pumped into it? A. Yes, oil was pumped in.

Q. Down the tubing? A. Yes.

Q. And tried to establish circulation in that way? A. Yes.

Q. Before your acid was put in the tubing? A. It was not to establish circulation. It was more to get oil coming from the tanks. We got some oil down the hole. The tanks were setting on top of the hill, and the oil pumps were connected to the tanks, and we intended getting some oil into the tubing.

Q. You wanted to fill the tubing? A. No, we couldn't fill the tubing at that time. We didn't—you mean before the blanket or before the acid?

Q. Before the acid? A. Yes, we tried to establish circulation at that time. You are correct.

Q. And you filled the inside of the tubing and the outside of the tubing? A. We couldn't get circulation with the oil.

Q. How far did you get the oil to come back up outside the tubing? A. We put in 90 barrels of oil, or I should say Halliburton pumped in 90 barrels of oil and he couldn't fill the tubing, so Mr. King, who was supervising the acid work, stopped putting the oil in, because we couldn't establish circulation. There was no use pumping any further in. We only had about a hundred barrel on hand in the tanks.

Q. What equipment did you use in handling that oil and introducing it into the tubing? A. Halliburton's equipment.

Q. It ran through the Halliburton equipment? A. Yes.

Q. At your request? A. Yes.

Q. That was Michigan oil in those tanks, was it not? A. Yes, sir.

Q. Do you know whether or not Michigan oil contains mercaptans? A. No.

Q. You know what mercaptans are? A. No.

Q. Do you know whether Michigan oil has a characteristic odor? A. A what?

Q. A characteristic odor, strong odor? A. Some oil has stronger than others.

Q. Well, did this oil have an odor? A. Buck oil is always quite a sweet oil.

Q. Did it have an odor? A. I could tell it was oil, crude oil, by its odor.

Q. Did it have one of these bad smells, that some of these Michigan oils have? A. No.

Q. Did you try it to see? A. I have seen a lot of it, and I don't remember that that particular well had any sour oil.

Q. You don't remember whether it did or not? A. No.

Q. Did you request that that oil be handled through the Halliburton pumps or the Halliburton equipment? A. I did not request directly, no. I asked them to give me an acid treatment in their regular way. I assumed that they would use their equipment.

Q. Didn't you ask that they pump that oil into the well or into the tubing through their pumps? A. Yes, I believe I at least conferred with them on it. I don't remember our conversation.

Q. And that oil went through that system before the acid went through the same system, did it not? A. Through the pumps?

Q. Yes? A. Yes.

Q. And when the acid was handled by those pumps, it was discharged into what? A. Into the Halliburton pumps.

Q. From the tanks? A. From the tanks.

Q. On the trucks? A. On the truck, into the pump, Halliburton pump, into the well and tubing.

REDIRECT EXAMINATION

By Mr. Conner:

Q. You live in Mt. Pleasant, do you not, Mr. Brown? A. I do.

Q. How long have you lived there? A. Since 1932.

Q. How long have you known, if at all, that Halliburton Oil Well Cementing Company have a place of business in Mt. Pleasant? A. I believe it was 1934, when I first knew the Halliburton men themselves. I think they had some equipment in before that, but I wouldn't be too sure about it. I think it was 1934 when I first—

Q. (interposing): What is your present knowledge as to the business that Halliburton transacts out of its station in Mt. Pleasant, Michigan? A. Well, I see the trucks there.

Mr. Lyon: At the present time? A. And equipment.

Mr. Lyon: There is not involved anything subsequent to the filing of this bill.

Mr. Conner: How long have you known that Halliburton in Mt. Pleasant was in the business of acidizing wells? A. I believe that was in 1934.

Q. You come in contact a great deal with operators in your work, petroleum operators, do you not? A. I do.

Q. Is it not common knowledge among those operators that Halliburton Oil Well Cementing Company operates a station at Mt. Pleasant, Michigan, and their business is acidizing oil wells? A. Yes.

Q. Is it common knowledge that Halliburton would supply the acid? A. Yes.

Q. Supply the blanket? A. Yes.

Q. Supply the surface tension reducing agent? A. Yes.

Q. Now, when such services and materials are supplied, who actually furnishes the equipment with which those materials are put into the well? A. Halliburton Oil Well Cementing Company.

Q. Now, does the operator in any instance ever supply the pumps or equipment for putting those materials in the well? A. Not that I know of.

Q. I would like to have you tell the court this: In this particular treatment of this Knight well for the Petroleum Investors, the Halliburton treatment of April 24, in the year 1939, I believe, is it not— A. That is right.

Q. —did Halliburton have any way of knowing that the Dow Chemical Company was to ultimately pay for that treatment? A. Not that I know of.

Q. You didn't tell Halliburton? A. No.

Q. That Dow would ultimately pay? A. No, I didn't.

Q. Then, in this instance, perhaps you can tell us wherein the services that Halliburton rendered to the Petroleum Investors was any different than that which it would have rendered to any other operator?

Mr. Lyon (interposing): I object to that. A. I don't believe there was any difference.

Mr. Lyon: I object to that on the ground it is only within the extent of the witness's notion what their service is that he can answer.

The Court: Well, you don't claim it was any different, do you?

Mr. Lyon: Between what?

The Court: Well—

Mr. Lyon (interposing): I don't know what they are going to claim for this.

The Court: What they claim is that you treated them like anybody else over in that district, as I understand it. That is what you want?

Mr. Conner: What I am trying to show, Your Honor, is that Halliburton is in the business of acidizing oil wells, and they have equipment. They offer acid, they offer pumps, they offer surface tension, and you call them up to treat your well and they treat it the same as if I called them up. There was nothing any different because they treated this well for which we were forced to pay in order to have a man present, Mr. Brown, for the purpose of taking

samples. There was no difference in the way it was treated.

The Court: What you want to prove is that is the way you know it was treated, and you want to show that that is their usual way of treating wells.

Mr. Conner: It is so far as we know, and I think it is up to them to show it was different, if it was.

The Court: Well, that is something particularly within your knowledge, and I will let them prove it in a pretty slip-shod sort of a way.

Mr. Lyon: That is quite all right.

The Court: Because it is so easy for you to dispute.

Mr. Lyon: We may agree, Your Honor.

The Court: I thought probably—

Mr. Lyon (interposing): That there was no difference, but I want to know what they are going to say they found in these samples and what they attribute what they found to before we agree that that well was done under this witness's direction and is typical of the wells that we do in Michigan.

The Court: Well, so far as their proving it, but you don't want them to get in that that was typical until you know what they claim was in there.

Mr. Lyon: That is right.

The Court: I think you are quite right in that reservation, and I hadn't covered that phase of it. So far as his observation goes, the treatment of this was the same as any other, but he hasn't covered those items concerning which they say they might want to object. That is when you get down to the analyses.

PAUL E. FITZGERALD,

a witness called by plaintiff, testified as follows:

DIRECT EXAMINATION

I live in Tulsa, Oklahoma, and am employed as a geologist by Dowell, Inc. I have a degree in geology from Ohio State University, have done graduate work at the University of Michigan and have been employed by Dowell since 1933. Upon leaving the University of Michigan I taught school and later worked for the Pure Oil Company as a geologist. The most important of my present duties is keeping up with developments in the various oil fields throughout the country wherein the services of Dowell Incorporated might be applicable.

I have made a study concerning the limestone well producing fields of the United States with reference to the date in which the various limestone fields in the various well producing states were discovered. This study was completed within the last thirty days. It was begun about the first week in July, 1941. It was made, according to my understanding, for the purposes of this suit. The survey is in two sections. The first section contains three parts. Part 1, or Sub-1 of the first section of the report lists the earliest limestone discoveries in the various fields throughout the United States. We give the location and the name of the field and its date of discovery. Part 2, or Sub-2 of Section 1 of the report, indicates the approximate number of fields producing oil from limestones that were discovered prior to 1932, and Part 3 shows the approximate number of the oil companies that were known to be operating in these limestone fields prior to 1932.

Section 2 of the report lists the states and shows the names of the companies that were operating in the states in fields that were discovered prior to 1932. These are limestone fields, you understand. It also shows the num-

ber of well treatments that have been made for these various companies. This doesn't mean that these companies were operating in the state prior to '32—it only means they were operating in fields producing oil from limestone that were discovered prior to 1932.

(Here the report was offered and admitted as PX-192.)

Mr. Lyon: I object to the report and its offer as being hearsay in character. There has been no foundation for it at all as to its character, what weight can be given to it or whether it is admissible at all.

The Court: I recognize the importance of that. Your people are experienced in this, familiar with it, and if you find a few defects in it, bring it to my attention.

The Witness: The information included as part of the report, Subs. 1 and 2, which list the names of fields. That part of the report is a matter of record. There are various publications from which that information can be obtained. It is merely a historical statement of the name of the field, its location and its date of discovery.

The Court: Now, the other side can check that.

Mr. Conner: Yes, your Honor.

The Witness: The information in part 1, as to the names, locations, and time of discovery of the fields, is a matter of record. Sub. 2, or the part that has to do with the number of limestone fields that are producing in these various states, or were producing in them prior to 1932, is also a matter of record. It is published data, that is, information that is available in any publication that has to do with the history of the oil producing industry.

With regard to Part 3 of the report, that information has been secured through our various district managers and engineers throughout the areas in which we operate. We have listed in this section of the report the approximate number of companies that were known to be operating in these various fields prior to 1932. The list is not complete, because in some cases we have no way of checking exactly the names of all the companies that were operating. However, we are quite confident that the names that are listed

in my report are correct, and this is intended only to show the more important operators.

The Court: What do I understand you to mean by that word "state," where it says, names of some companies that operated in the state prior to 1932.

Mr. Conner: If your Honor will look at the top of the page, this first page refers to Ohio, and in Ohio he gives you the limestone fields, and the date of their discovery in Ohio.

The Witness: If you will follow the report as I go through it you will find under "I" the first limestone fields, and I have listed them. The first one is the Lima, Ohio, field. It is located in Northwestern Ohio, and it occupies a large number of counties. That field was discovered in 1885. The producing formation is the Trenton limestone. The next field that I have listed here, and it is not a very important field, is the Newburg field which is in Northeastern Ohio, south of Cleveland, and it produces from the Newburg limestone and was discovered about 1915. I haven't taken the trouble to list the other limestone fields which are known to be producing and all prior to 1932. There weren't many important limestone fields in Ohio, outside of the Trenton field in Northwestern Ohio.

The Court: This is explanatory to me, since I have found out about that.

Witness: Now, there are no, as I said previously, no records of the exact number of operators that were in these fields prior to 1932, but we do know that prior to 1932 the companies listed below were known to have operated some of the important ones: Pure Oil Company, East Ohio Gas Company, Ohio Fuel Supply Company, Ohio Oil Company, and Sun Oil Company, and many others.

The next page. The next state in which oil was found in limestone is Indiana, and here we show the same outline, and again we find that the first field was the Trenton field in Northeastern Indiana, occupying several counties. It was discovered in 1886. And the next limestone discovery in Indiana was in 1893 when another limestone was discov-

ered in Decatur County. We find from the record that there were approximately eleven limestone fields in Indiana prior to 1932, and our record of the number of companies operating in these fields prior to 1932 was only four, and among these are the Ohio Oil Company and the Siosi Oil Company.

The next state in which oil was discovered from limestone was Kansas, and that would be the third page in this report. We find that the first production of oil or gas from the limestone in Kansas was in 1888 when the Lyons gas field in Rice county was opened. The next limestone field in Kansas was the little Dexter field of Cowley County which was opened in 1903. In 1917 the famous Eldorado field of Butler County was discovered. Our records or the records that are available indicate that there were 78 limestone producing fields in Kansas prior to 1932.

The Court: Now, I notice that he is simply reading from this, which is apparent. I wonder if we couldn't save time, if there is nothing more only to do that with him, I would suggest that we let Mr. Lyon ask him any questions he wants to before night, and then have it over night to use.

Mr. Conner: There is a second part to this report which I think needs some explanation, and if Mr. Fitzgerald will explain it, why, perhaps we will not have to go through each state.

The Court: All right.

The second section of the report, beginning at page 20, lists the states and the companies in those states for whom we have acid treated wells. And these companies were operating in fields that were discovered prior to 1932. If you will take the first page of this section of the report you will notice there are three states listed, and you will notice that in Illinois we treated 99 wells. You will notice that in Illinois we have listed three companies and a miscellaneous group, and the total number of wells that were treated is 99. These wells have all been treated by Dowell Incorporated.

Q. And is it your statement that these companies here listed and under each state are operating in fields which are

limestone fields and which were discovered prior to 1932? A. That is right.

Q. And that is true all the way through the rest of this report? A. That is right.

The Court: And these number of wells have been treated during what period? A. Since 1932 up to the end of 1940.

For Indiana there were only 91. And in Kansas there are two pages here, but that total was 731 for Kansas. In Kentucky there were 123. Louisiana 1319. Michigan 763. New Mexico 323. Oklahoma 2293. Ohio 155. West Texas 943. North Central Texas 104. Texas Panhandle 417. The South Texas area, that is the Balgoni's Fall area, 154. Or a total for all of Texas of 1618. There were 349 treatments made in Montana and 80 treatments made in Wyoming.

Mr. Lyon interposing: Only one thing I would like to know before we adjourn, if you can tell me whether or not he has got some appendix or supplemental information to this report that shows where these different items of information came from, that I can check against the report and shorten any questions we have about it. For instance, how do you know that the Bell & Scholl Company, Item C on the first page of this report, was in business prior to 1932? How do you know that? A. Well, because I know the company and I know that they operated in Ohio prior to 1932. I do not know every one of these companies on this report. In the case of Ohio, I know all of those companies operated there. As a matter of fact, I grew up in Ohio. I did not know them before 1932.

Mr. Lyon: Well, then, what is the source of your information that they were operating in Ohio before 1932? A. I told you a while ago that I made the statement that this report was worked up in part by our district managers and our treating engineers in the field, and part of this report was compiled by them. Their original reports are available here in this city. Such work as appears in this report that I personally did not do was done under my

supervision, and I have reports from the men in the field to me which include the other data in these reports.

Mr. Lyon: Do those reports show where the other men got the data? A. No, I don't think they do, completely.

The Court: I am admitting this. I say, I am going to admit it, and the weight that I give to it will depend somewhat on what I find out about the regularity of it later on. But I am letting it in now, tonight, in order that the defendant may look it over; and I will, before I am through, find out how much they know, and what they do not know about it, and if there is anything—well, it seems that if it is pretty bad, they should have something that would show what is absolutely wrong with it, and if they—your proof to support it is so weak, and I recognize that it would cost a fortune, and take more time than I would give you to prove all that is in it, to hold you to strict evidence; so I am going to do that, but I am letting it in, and giving them a chance to dispute it, and if they do not dispute a single item, I will think that it is pretty well prepared. If they find some things in there that are wrong, I will hear about it.

The Witness: While employed by Dowell Incorporated I have engaged in the actual treatment of oil wells with acid. That work was begun in March of 1934 and later in 1934 I was sent to the Rocky Mountain area where I opened a treating station at Shelby, Montana. I was located there as a treating engineer and district manager until the close of 1934, when I was transferred back to Michigan. During that time we treated wells in the various oil fields in Montana, which included Kevin, Sun Burst, and Pondera, these fields being located near Shelby.

I have made a particular study of many fields in Montana to show the effects of acidizing. I was interested in the possible effects of acidizing on limestone and its effect on the recovery of oil and in that connection I became interested in this small Pondera oil field, which at the time when I was there had about 154 wells in it, and the field was not being pro rated. Dowell was doing all of the acidizing and it was quite easy to secure production information. In that

connection, after my return to Michigan in December of 1934, in February of 1935 I began to make a more serious study of this field, and wrote a letter to the Stanolind Oil and Gas Company at Casper. This letter was directed to Mr. John Evans who was their petroleum engineer in the Rocky Mountain area at that time. I requested from him information relative to the effect of acidizing on their wells. I have a letter from Mr. Evans in reply, written February 19, 1935. I shall quote one paragraph from this letter:

"Acid treating on our leases in this field—" Mr. Evans is referring to the Pondera field. "—has been very profitable and has, I am satisfied, materially increased the ultimate production to be expected from those leases. The best evidence that this is true is that the wells making around a barrel per day prior to acid treatment were increased up to ten or fifteen barrels per day by the treatment and are still maintaining this increased production some six months later. Nine wells were very near their economic limit and could not have been expected to produce much more oil before being abandoned had they not been acidized."

About a year later, as a matter of fact it is more than a year later, it was in June—May 29, 1936, I wrote a letter to Mr. Evans' successor, Mr. N. P. Huntington at Casper requesting later data and more complete information on the effect of acidizing in this Pondera field. More than a year had passed, and I was anxious to know whether these wells were holding up, and Mr. Huntington replied on June 2nd, and I shall quote one paragraph:

"To provide a picture reflecting the answers to your three questions I am attaching a sketch representing the production from our Pondera property. We operate forty-seven wells there. I estimate that acidizing has directly resulted in 80,000 barrels of oil to date, and that our ultimate recovery has thereby been increased 250,000 barrels. This latter figure is of course more in the nature of a guess than an estimate."

The Court: What were the three questions? A. I will read the paragraph in which I stated the questions. "I am

wondering, therefore, if it would be unethical to ask you to write me a letter outlining in a general way some of the data that you may have regarding the value of acidizing in Pondera. That is—(1) How much has the ultimate recovery of your producing properties been increased by the intelligent use of acid; (2) how much oil has been recovered as a direct result of acidizing, and (3) what is the present production as compared to production before treatment."

The Court: All right. Now read the other. A. He says: "I am attaching a sketch representing the production from our Pondera property. We operate forty-seven wells there. I estimate that acidizing has directly resulted in 80,000 barrels of oil to date, and that our ultimate recovery has thereby been increased 250,000 barrels. This latter figure is of course more in the nature of a guess than of an estimate." Then Mr. Huntington attached this curve or graph to his letter. This graph is merely a decline curve of their properties in the Pondera, beginning with 1931, extending to 1935, and it shows the production in barrels per day, and it shows acidizing in 1934, and it shows there was a change in the direction of the curve, indicating more oil was being produced following acidizing than there was before. The new curve is about a year and a quarter old. The difference between the old curve and the new curve, according to Mr. Huntington, represents an actual increase in production of 80,000 barrels for that period and that if they extend the new curve out from the point where it intersects the old curve, they will get approximately 250,000 more barrels than they would have if they had not acidized the wells.

The Court: When does the curve start? A. At the beginning of 1934 when three wells were acidized.

The Court: January 1st. A. It wasn't that early. I can't tell from this, exactly. I should say probably February, 1934—that is when 3 wells were treated, and about July or August of '34 they treated 20 additional wells.

The Court: It began what time, then, the first one? A. The first three wells were probably treated in Febru-

ary of '34, and the additional 20 wells were probably treated in July or August of the same year.

Mr. Conner: I offer the curve referred to as PX-193, together with the letters explaining the same.

The Witness: These figures on the Pondera field in Montana with respect to production of oil from the field which I have given are production figures I got from someone else as the source. I have myself made a survey or study of the production of this field, which is reflected in the chart I have in my hand.

Mr. Conner: I offer the chart as PX-194.

Witness continuing: This chart is a decline curve of the entire Pondera oil field and it is nothing more or less than the plotting of the production data by months for the total field. I began my curve in January '33 and I kept it up to November, 1937. The curve shows, beginning in January '33, they were producing approximately 32,000 barrels per month, and that there was a gradual decline from that time down to July of 1934, when they were producing about 28,000 barrels per month. Acidizing in the field was begun in July—July 28, 1934, and there was an immediate increase in production. You must understand that during this period no new wells were drilled, so that the change in the direction of the curve must be attributed to acidizing.

Q. During which period is that you refer to? A. From the time the acidizing was begun in July of 1934. This curve moved upward very rapidly beginning in September, 1934, and in October of '34 the field was producing 34,000 barrels. In December it was producing approximately 41,500, and then the curve bobs around quite considerably. There is a big drop. There were 154 wells in the field in all. I don't know exactly when the last producing well was drilled in this field because there were no wells drilled in the field that were commercial producers during the time I was there. So I think the last producing well was drilled somewhere in the latter part of '33. I do know there were no new wells drilled during the period I was there. There were dry holes all around this little field.

Q. And yet this curve show there was more oil produced after 1934 as a result of acidizing than there was oil produced in 1933? A. That is right.

The data on this report shown in the little boxes down at the bottom, for example, 1933, show 351,099 barrels. These figures came from the Oil Conservation Board of Montana. I have here a certified copy of a statement of the crude oil produced and refined in Montana by fields from the discovery date to June 30, 1939.

Mr. Conner: I would like to offer in evidence as PX-195, the Montana Oil and Mining Journal of Saturday, January 26, 1935.

(The document above referred to was thereupon marked Plaintiff's Exhibit No. 195.)

Mr. Lyon: May we have an understanding that in objecting to the witness' summary of his report, PX-192, that that applies to these other exhibits without being repeated.

The Court: Yes, it may.

Mr. Lyon: I mean exhibits that he is introducing with reference to that matter. The exhibit that I refer to is this large report of his.

The Court: It is of that type and your objection will apply to it.

Mr. Conner: This article, PX-195, is with reference to this same field and pool at Pondera, Montana, and the article states:

"Pondera production up 22,000 barrels.

"Use of acid boosts field production total 3,675,391 barrels.

"With no new drilling, Pondera oil field increased its production during 1934 by 22,210 barrels over 1933 according to official production figures compiled in the office of the Petroleum Conservation Board.

"This increase in production was due to the use of acid on the lime formation in these wells, chiefly during the latter part of the year.

"The 1934 production brings the total yield of the field up to 3,673,391.74, which has been marketed for slightly more than $3,000,000."

Q. Now, Mr. Fitzgerald, might I ask you, do you have in your possession any publications or releases or data from the Oil Conservation Board of the State of Montana which mentions acidizing? A. I have in my hand Bulletin S-1, dated November 13, 1936, published by the Oil Conservation Board of the State of Montana. This is a certified copy signed by R. P. Jackson, Secretary of the Oil Conservation Board of the State of Montana. On page 20 of this report there is a statement regarding the use of acid in Montana oil fields. I shall read this short statement.

I had nothing to do with the writing of this article and do not know who did write it. I first saw it about ten days ago, and never heard of it before. The title of the article is "Acidization." It reads:

"The treatment of zones in the Ellis-Madison contact horizon showing oil in newly drilled wells, as well as old 'stripper' and apparently exhausted wells, with hydrochloric acid compounds of various kinds has been generally most amazingly effective in stimulating oil and gas production. This is especially true in the Kevin-Sunburst field, where most of the acidation work has been done. The first record of acidizing operations appears in 1933 and from that time to December 31, 1935, the records show that 464 of the 980 producing, or 'shut-in,' wells in the Kevin-Sunburst field have been acidized, one time or more. Acid treatment of newly drilled wells apparently non-commercial converted them into prolific oil producers in most cases. Applied to old, and apparently exhausted, wells, it revived them and sometimes increased production to a level never before reached. In comparatively few instances have the results of acid treatment been disappointing to the operator. It may be noted in statistical table '1-A' that since acid treatment of wells in Kevin-Sunburst field was commenced in 1933, out of the total 84 new wells drilled during 1933, 1934, and 1935, only 15 were abandoned as initially

dry or non-commercial, that is, slightly less than 18 per cent, whereas during the years 1922 to 1932, inclusive, out of total 1528 wells drilled, 399 were abandoned as initially dry, that is, slightly more than 26 per cent. It is also interesting to note in the same table that from 1922 to 1932, inclusive, the 'wells abandoned after producing operations' numbered 217, whereas during 1933, 1934 and 1935, only one such well was abandoned. It is not within the scope of this statistical bulletin to give a detailed history of acidizing operations in the Toole County fields or to discuss the possibilities connected with the more general use of acid in the future. If any reader should desire any further information on the subject, it is suggested that inquiries be addressed to the concerns engaged in the business of acidizing wells, to-wit:

"Dowell, Incorporated, Shelby, Montana.

"Big West Acid Company, Kevin, Montana.

"Oil Well Acid Treating Company, Kevin, Montana."

Incidentally, the Big West Acid Company and the Oil Well Acid Treating Company later became licensees of the Dow Chemical Company, and since 1937 or 1938 the Big West Company has left the field, but the Oil Well Acid Treating Company or its successor is still a licensee of the Dow Chemical Company.

The Court: Of all those that were named in there that they might write to to get the information, how many of them were already under license from the Dow? A. At the time of this article only Dowell, Incorporated.

The Court: None of those others had been licensed? A. Not at that time.

The Court: How soon after were they? A. The Big West Acid Company became a licensee in 1937, I believe, and the Oil Well Acid Treating Company, or its successor, became a licensee in I believe 1938.

The Court: Did you have anything to do with their becoming licensees? A. No, sir. I left the Shelby area in December, 1935, and this article was published November 15, 1936.

Witness: May I read the last paper?

Q. (By Mr. Conner): And you had nothing to do with the writing or publishing of this article? A. No, I never saw this publication until you handed it to me a few days ago.

Mr. Owen: Ever hear of it before? A. I did not.

The Witness (reading): "The Oil Conservation Board regards the acid treatment of oil and gas bearing formations as the most important and valuable contribution yet made to the expansion and conservation of our oil and gas resources and its development and use under proper regulation and control is destined to be of incalculable benefit to the State of Montana and its citizens."

Mr. Conner: I offer this Bulletin S-1 as PX-196. which exhibit shall include the certificate appended to it. R. P. Jackson, Secretary of the Oil Conservation Board of the State of Montana, identifying this publication, stating the same is a certified copy.

The Court: Now, I think your objections are all right, but I will give you a chance. PX-195 is this Journal. Any objection to that?

Mr. Lyon: Yes, we make the same objection we make to all exhibits to PX-192.

The Court: That applies to both of these exhibits, 195 and 196, which I admit, and you have your objection.

Mr. Lyon: I have no cross-examination of this witness.

ORLIN W. LYONS,

a witness called by plaintiff, testified as follows:

I studied mechanical engineering at Oklahoma Agricultural and Mechanical College for four years, and have been employed by Dowell Incorporated since August 7, 1936, first as a treating engineer engaged in acidizing oil and gas wells and then as a station manager engaged in the same work and supervising the work of others.

From July, 1937, until September, 1938, I was station manager for Dowell, Incorporated, at Borger, Texas, where my duties were to acidize and supervise the acidizing of oil and gas wells in that area for Dowell. Commencing about July, 1937, I made a study of the effects of acidizing on gas wells that were acidized by Dowell in the Borger, Texas, area. Prior to this a few gas wells had been acidized, but they were more or less unsuccessful. Dowell checked the results of the treatments it made. This was done by ascertaining from the well owner or operator the gas production of the well before and after acid treating it.

The results of this study were made public in an article I prepared entitled "Gas Well Acidizing" appearing in the September 12, 1938, issue of the "Oil Weekly."

Mr. Conner: A copy of the article is offered as PX-327.

On page 38 of the article appears Table 1 entitled "Increase in Flow Obtained by Acidizing Texas Panhandle Gas Wells." This table lists gas wells designated by the numerals 1 to 47, and for each well shows the number of gallons of inhibited hydrochloric acid used in treating the well, the number of stages used in the treatment (the production of gas from the well before acidizing, the production of gas after acid treating it, the percentage increase and the increase in cubic feet of gas from each well per gallon of acid used to treat it. For instance, example No. 1, 3,000 gallons were put in at stage 1, the production before acid was 3,000,000 cubic feet per day and after acid was 6,800,000.

Table I of the article refers to these wells only by numbers 1 to 47, and gives no data which identifies the owner of the well. I now produce three typewritten sheets marked "Table 1" and "Table 2." The information on these sheets appears to be the same as that contained in Table 1 of the article in the Oil Weekly, except that the typewritten sheets give Dowell's treatment number, the company name, the well name and the treatment date.

Mr. Conner: The three typewritten sheets are offered as PX-328.

This information and data as to production before and after acidizing and the identity of the well was furnished by the well owner, while the data concerning the date of treatment and quantity of acid used came from the records of Dowell, Incorporated. The data under "Treat. Number" are Dowell's Serial Numbers. The wells are listed in the order of their size, for purposes of comparison, which accounts for these numbers being mixed up. The last two columns are calculated values. The figures under "Before Acid" and "After Acid" refer to cubic feet of gas.

The well showing the greatest percentage increase on this report is Treatment No. 511 for Phillips Petroleum Company, being from 4,690,000 to 38,698,000, or 725%; the one showing the next highest increase is No. 401 for Shamrock Oil & Gas Co., being from 12,000,000 to 81,000,000, or 575%, and the third highest is No. 463 for Panhandle Eastern Pipe Line Co., being from 5,400,000 to 34,400,000, or 537%.

During the period from July, 1937, to September, 1938, Dowell, Inc., treated approximately 80 gas wells, about 40% of which were treated by me personally and the rest were treated under my supervision. During the period for which data was collected there were 67 treatments, so that there were twenty treatments not referred to in the article in the Oil Weekly.

As to why I didn't include those other wells in this article, I figured that that was a representative group of wells that would show the type of work that we were doing at that time, and I left out several of them because they

were not representative wells, there were particular conditions attached that didn't make them a representative treatment. For example, in the Texas Panhandle you have a very complex formation. You have productive zones out there that are sometimes 600 feet, and in those productive zones will be scattered shale, dolomite, lime, arkosic material, and granite wash, and those wells are drilled with cable tools, and it is rather hard to collect the samples of the formation from a gas well because after you once start drilling why the cuttings blow out as fast as you drill, and they are blown out of the hole at such high velocity it is rather hard to catch your samples. And, for that reason, sometimes the drilling logs of these wells were rather incomplete, and there have been instances where all we had to go on was the company records, and some of these wells might not show any granite wash. Granite wash is granite pebbles carried down from the granite ridge in this particular formation, and it is non-acid-soluble, and it is permeable, and if your acid goes back in there there is no reaction, and you couldn't expect to get an increase in acidizing if you put your acid away in the granite wash.

The Court: What makes you put it in there, if you know that? A. If you don't know it is there, if the operator tells you here I have got a lime well, I would like to have it treated; the pay is from such and such a depth to such and such a depth. Why, you have no records of that.

The Court: Can't you believe those men, what they tell you? A. Well, you have to.

The Court: But that is what you believe for your statistics, if it is on top, and what they did get afterwards, these same men that are so untruthful? A. They are not untruthful, Your Honor. It is just the fact that they can't catch these samples, and they don't know the condition.

The Court: How do you know afterwards, then? A. Well, afterwards, if you put acid into a well, into a gas well, and it is a limestone formation, you don't get live acid back out. It is reacted acid. But in several of these treatments we found we had put acid into a non-reacting or non-

soluble formation, because we got live acid back out of them. Then we were into either the granite wash or the arkosic zone.

The Court: You mean there wasn't any lime in there at all them? A. Well, yes. The upper section would be lime, and the bottom section where the acid would—the granite wash is more permeable than the dolomite above, and your acid is going to go where there is the least resistance to flow.

By Mr. Conner:

Q. I show you a tabulation on gas wells, and ask you to state whether or not that appears to be a complete list of some 67 gas wells, of which you made a survey, to show the effects of acidizing those wells, and state whether or not that list includes the 47 wells that you reported in your printed article in the Oil Weekly (handing document to the witness)? A. It appears to be that.

Mr. Conner: I ask that this be marked PX-329.

The Court (indicating): Now, begin at the beginning, begin at the top and go down, and I want to put a mark on the original, of those that are not in your advertising, so that I can look at them. I am marking them right on the original so if anybody else is ever interested they can look; 402 is left out. A. 407 and 399-A are all one treatment and are left out, 405 is out; also 468, 469, and 492, and all the rest, 493, 96, 97, and all down to the bottom of the page are left out.

The Court: Well, now, these numbers—now, what do these treatment numbers mean, are they the order of treatment, or what? A. That is the order. Now, you see that they are not in—they are not in line there because we treat oil wells also; these are just gas well treatments. Treatment 503 to 506 might mean we treated 504 and 505 for oil well treatment.

The Court: But these are in the order of time, this arrangement, are they the treatment numbers? A. That is correct, I am pretty sure it is. Referring to PX-328, which is the table 1 comprising the wells that I reported in my

written article, the highest percentage of increases was 725 and the lowest percentage of increase was 29 per cent.

Referring to PX-329, the percentage increase of each of the wells that I left out was as follows: No. 374, the percentage increase was 73.

The Court: What is that figure from? A. That is taken from this sheet here showing the percentage increase of the wells that are left off of this sheet.

The Court: You did include there a 69 though and a 33, in those that you did publish? A. That is right.

The Court: And you left off a 73, which is higher than two that you have left off that I see? A. I would like to point out that these treatments are made in stages and due to the type of formation we are dealing with we had to more or less feel our way along in these treatments, and we put in one the gallons of acid to clean off the face of the pay, and then we would blow that acid out, take the dirt and the shale partings, and general impurities out of the well, and then introduce some fresh acid down and inject that out into the formation, and as a general rule the washing operation, which was the first stage, didn't show a particular increase in production, all that did was prepare the well for the subsequent acidizing stages, and so in order to tell whether we were going to do any good or not we had to put two stages of acid in there, and if the well looked as though it wasn't going to respond, we left the last stage out, we didn't go ahead and complete the treatment, and that is one of the reasons why I left out these ones here that you see are zero per cent and you will notice there are 4000 gallons—

The Court: Now, weren't all the things that you left out honest hazards of your business? You were honest in all you did, made an honest effort with all of them? A. That is right.

The Court: And these were hazards that went wrong? A. That is right.

The Court: But you left them out when you went to the advertising, and they are legitimate hazards of the busi-

ness, they are things if you were going to do the thing over again you would run into those same troubles, wouldn't you? A. Yes.

The Court: And the man, if that treatment doesn't turn out good and they don't get rich out of it, that is a legitimate, honest answer, and, in order to show the whole picture, you need the whole sheet there, don't you? In order to just show what you actually accomplish and it is fine, it is good, but isn't that true, now, that in order to show just how much good you do and how much you don't do, you need the whole record in that part of it? A. Well, we could tell now a little more about how to do that, and we could avoid such wells as that, because the public out there is educated to what is necessary for proper acidizing, and they can keep their wells in such a manner that we have a little more data on the well before we start acidizing.

By Mr. Conner:

Q. Will you please continue and point out to his Honor the ones, starting with the wells that you left out, by treatment number, and refer to the percentage increase, if any? A. Well, there is treatment No. 402, is zero per cent increase. 407 is zero per cent increase. 405 is zero per cent increase.

The Court: Did you get any decreases at all? A. None here, your Honor.

There are 7 wells on this tabulation that show zero per cent increase, down about the middle of the second page. Commencing with the treatment No. 493, on the second page, and from there down to treatment 535, I did not include any of those wells in my printed article.

Q. Will you just run your eye over the column which says percentage increase, and read off the percentage increase of those wells that you did not include in your published article beginning with treatment 493? A. 315 per cent. 92 per cent. 126 per cent. 45 per cent. 89 per cent. 55 per cent. 63 per cent. 726 per cent. 401 per cent. 608 per cent. 957 per cent. 8 per cent. 140 per cent. 35 per cent. These were not included in my written article.

The Court: When was that article written? A. It was written in—the rough draft was prepared in the latter part of July, or August.

Q. When were these wells treated? A. The last date I see is June 30.

Q. Were the figures on these wells available to go in the article if you had so desired, or had elected to put them in? A. They were.

Q. How does it happen that the last fifteen were left off? It looks to me as if you started to write that article, but you did not take a single one of those later ones. Have you got some explanation as to why you left out that period of time? A. The only reason I can give is that when I was preparing this, I had the list in front of me, and I took them down until I thought I had enough examples, and just took them in order, and left out the ones that I did not consider representative.

The Court: Are you sure that you had this list? I see that every one of them is left off here, which leads me to incline to think that you did not have those figures. A. I had the figures available at the time. I don't have my original data sheet here.

The Court: You have not put down in your published article a single one that you did not get an increase? A. That is right.

The Court: You have left them all out. It is not a fair showing, to make statistics in that way, and that is the reason why I do not accept it, in that way. I accept this complete one here, but that other one doesn't mean anything to me at all. I have got all I want on this one sheet (PX-329).

Mr. Conner: We are producing a complete sheet here, and I believe I asked the witness why he did not have this data before him, the list of wells. at the time he wrote the article, and he tells me, and he tells you that he did. That is all I know.

The Court: I think he is mistaken. I think he is absolutely honest, but I think he is mistaken about that. There

is nothing that people get more mistaken about than on dates. A. I don't think I am, your Honor.

The Court: You were getting out this history up above, and then you come down here, and there are some good ones down at the bottom there, and if you had had them right before you, I am of the opinion that they would have gone in, and I think you are absolutely honest with me, but the extent to which people, when they are interested in a thing, are influenced by that, is something amazing.

By Mr. Conner:

Q. Mr. Lyons, I ask you if you have made any particular study or survey, either by actual work in the field or by study of Dowell Company records, which would reflect the time that acid is in contact with the tubing during an acid treatment of wells, and, if so, state how you made that survey, and when you made it, and where you got the information? A. Well, of course, my duties have been, in the past, to check treatment work in the office in Tulsa for treating techniques, and, of course, I did not compile any data at that time on the length of time it would take to introduce acid. The average length of time it would take to introduce acid in the well. But since this trial has started, I have had 122 treatment records sent up here on 97 consecutive Arbuckle dolomite wells in Kansas, and I have computed the—observed the length of time the acid was in contact with the tubing down those wells during those treatments.

Q. I hand you three sheets of paper and ask you if you can identify that as data taken from those 122 consecutive treatments? A. Yes.

Mr. Conner: I ask the reporter to mark these sheets as PX-330.

Q. I likewise hand you a sheet of paper and ask you if those are your calculations based on PX-330? A. They are.

Mr. Conner: I ask the reporter to mark that sheet as PX-331.

The Witness: I have in my possession the treatment

records from which PX-330 was compiled and have computed each of those treatment records for the 122 treatments in order to identify the treatment number, the owner of the well, the well name and number and also to find from the treatment records the time that the acid was in the tubing in hours. Where the well was treated a second time I have identified that treatment record by treatment number and shown how long the acid was additionally in the tubing by hours. In the last column of PX-330 I show the total time in hours that the acid was in the tubing for each of these wells. I compiled this from our company records.

The Court: These figures are kept in the ordinary course of your business? A. They are recorded on each and every official treatment.

The Court: And there are many purposes for keeping these other than advertising purposes in your business? A. Yes, sir.

The Court: I will admit it as part of—when I find a system of records and bookkeeping that is good enough for people to rely on in their own business, I admit them.

Mr. Lyon: If the plaintiff wants to take all the time it wants in acidizing a well with its inhibitors, that has nothing to do with what the defendant does. We have the records here of what the defendant does, and they have already been referred to. What the plaintiff does has nothing to do with this case.

The Witness: PX-331 gives the average gallonage used in treating 97 consecutive Arbuckle dolomite wells, comprising a total of 122 treatments. The average gallons of acid is 1089½ gallons. Average of maximum treating pressure is 528 pounds per square inch. The average time acid was in the tubing is 7 hours 1 minute. The average internal diameter of tubing shown in this treatment is 2.66. The average length of tubing shown in that treatment is 3211 feet, and on this sheet is computed the square feet of surface area in 3211 feet, which equals 2241 square feet, equals the average internal surface of the tubing in these treatments.

By Mr. Conner:

Q. Mr. Lyons, have you had any occasion to learn what the hauling charges are in the oil fields, that is, trucking charges, and, if so, tell the court how you came to learn that and what those charges are? A. During the time when I was station manager in Pampa and Borger, Texas, why, we had occasion to hire trucks to haul extra gallonage of acid out to wells, and then at several times later on, since that period, I have had occasion to hire trucks to haul special equipment out to wells in conformity with my duties in that capacity. For a medium sized truck, the average price is around $5 an hour. For the big, extremely heavy-duty trucks, it runs in the neighborhood of $7.50 an hour. In my work of treating wells with acid I have had occasion to learn what the costs or charges are of pulling tubing out of a well, and the charge or cost of running the tubing back into the well. Several times in the past, in working up new treating techniques, we have had to pull tubing and lower special tools into the well, and often in going over this type of treatment with the operator, why, the cost of doing this work was weighed against what we might expect in results from the treatment, and the average figure that I remember—of course, it can vary all over the map, but the average figure would be around $85 a day for a pulling unit and crew to run tubing. The figure will vary because of different depths of well, the different types of pulling machine, or whether the well has a rig front, or whether the rotary rig is still over the well. If you have to tie up a rotary rig to do this operation it would cost you much more. Taking that figure of $85 for machine time and crew time, you could run and re-run tubing in a 3000 foot well in about a day, and that would be $85.

Q. Have you read the Frasch patent recently? A. I have.

Q. You noticed therein that they proposed to use a specially prepared tubing for treating their wells under their method? A. Yes. They refer to either enamel-lined, enamel coat, or rubber-lined and rubber-coated tubing, or lead-lined, lead-coated tubing.

Q. And, in order to use such a special tubing, you would have to run it into the well and then pull it out of the well again? A. That is right.

Q. Before you could do that, you would have to also pull your normal tubing, and after you had used your special tubing, run the normal tubing back; is that correct? A. That is correct.

Q. So you assume that you would have at least two complete pulling jobs, that is, running and pulling?

The Court: Have you made any figures or estimates on the average value of the increase in oil, as to how much you increased the well? That is, the relation that that bears to the expense, of course, is just as important as the expense item? How much did you increase the value of each well, on an average? A. The percentage increase?

The Court: No. In dollars, the increase in dollars, if you have any idea at all? A. Well, that is kind of a hard question to answer.

The Court: I know it is. You don't know how long they are going to run, of course? A. One well may make only a gallon of oil, and it is temporarily closed by treating, and you acidize out the corner area, and you open the natural flow up, and you get a fairly big well, there you have got an awful big increase.

The Court: $85 does not mean much in the inducement proposition, or the discouragement proposition, unless I know what the stake is, do you see? In some places, and under certain conditions $85 is an awful lot of money, but in other places it is just a bagatelle.

Mr. Conner: But there would be two pulling jobs as a minimum, each of which would cost $85.

Mr. Lyon: If your Honor please, the point I am objecting to in connection with those figures is that they have nothing to do with the defendant, or nothing to do with anything that has happened in your district here in Michigan that the defendant has done. These are something the witness has taken from records in September, 1936.

The Court: But they throw some light on the industry

we are dealing with. I agree it doesn't show what you have done. And the very fact it occurs before this suit started, and I am satisfied it wasn't being done for the purpose of a lawsuit, it is a record of what you do in your own business there. Just what do you claim when you show how long they had it in? Your purpose is to show that it would eat a lot of iron and use up a lot of acid?

Mr. Conner: If it is raw uninhibited acid.

The Court: Yes, that it would use up a lot of acid and also eat up iron, you show it for two purposes.

CROSS EXAMINATION

By Mr. Lyon:

Q. Let us go back to this first table that you produced, or, this first exhibit that you produced. your published article, that is PX-327. During the time that you were acidizing those gas wells out in the Panhandle, the Chemical Process Company was doing the same kind of work, were they not? A. Not during the first part of the period, to my knowledge. I think that you will find that May, 1937, was the first of the treatments included in PX-328.

It is hard for me to fix the date when the Chemical Process Company started in that field, doing that same work, but it was roughly after the first of the year in—shortly after the first of the year in 1938. However, they were in the Hugoton area in Kansas in the latter part of 1937. I am not sure that the Chemical Process Company was not there in the Panhandle acidizing those gas wells as early as September, 1937, because they may have acidized a well or two from their Hugoton station, coming across the Oklahoma Panhandle down into the Texas Panhandle at that time.

My article, PX-327, was published in September, 1938, in the Oil & Gas Journal. In the earlier issue of the same publication, of May 19th, 1938, Mr. M. E. Chapman, of the Chemical Process Company, published an article on the

same subject entitled "Acid Treating of Gas Wells to Increase Production." It covers the same general line, acidizing gas wells, as was covered in my later article. The table in the Chapman article "Partial List of Gas Wells Treated in Hugoton Area, Kansas" refers to gas wells, but not using the same methods. We used a gas load method of treatment, where they used a water load method of treatment. That means after you get the acid into the tubing then to pump it, force it down, follow it down, we use gas and they use water. We have gas compressors, portable gas compressors to build up enough gas pressure, rather, on top of the acid, to overcome the resistance to flow in the formation.

By Mr. Lyon:

Q. Did the Chemical Process Company in the Panhandle obtain comparable results to those you reported that was obtained by your company on these gas wells? A. Now, during that same period I don't recall any production figures on Chemical Process' production data.

The Court: You had seen their publication probably before you got yours out there? A. That is the first time I have seen that, that I recall, your Honor. This publication says it was presented before a meeting of the American Gas Association at New Orleans on May 9th to 12th, 1938. I was not present at that meeting. I might have seen this publication before, but I don't recall it.

The Court: I take it the competition has been pretty keen between all you people; there haven't been many of you, and it looks as though you had a battle between you; hasn't there been real competition, real keen competition? A. We certainly had competition.

The Court: I imagine you are each reading all the other says, and all the advertising? A. Well, not from my own experience.

By Mr. Lyon:

Q. Well, you know, don't you, that you have had substantial, real keen competition from the Chemical Process Company in the fields that you have been working in ever

since you have been working for Dowell? A. That is right, there has been competition.

Q. Now, in this article, Mr. Chapman of the Chemical Process Company says this, after describing his method which you have already explained:

"By using this method a well was treated in the Panhandle of Texas in 23 minutes using 5,000 gallons of acid followed with a water load of 53 barrels. The well was allowed to be shut in 20 minutes awaiting chemical reaction. Before treatment the well had a rated potential of 16,900,000 cubic feet of gas per day. After treating, the well gauged 65,000,000 cubic feet. Samples of the spent acid solution following the treatment indicated that the acid was completely neutralized."

Mr. Owen: Now, if Your Honor please, I object to the reading of the paper into the record as evidence. If it is for the purpose of cross-examining the witness, all right, but it doesn't prove the facts stated in the document.

The Court: I think that is right. It is more advertising by a third party.

By Mr. Lyon:

Q. Now, isn't that description of the results obtained there consistent with the results that you know were obtained by the Chemical Process Company in that field, in acidizing those wells? A. Well, I can answer it this way, in that I haven't personally gone around to companies that Chemical Process treated for and asked them what their production results were. All that I would know would be hearsay.

I did not check up any of our competitors' results out there in the same manner that I checked up our own. During the time that I was out there, our competition treated very few wells, and I didn't check, actually check up on the production. I don't actually know whether they performed such an operation as they say and obtained such results as they say. I don't know anything about how long it took them to acidize the gas wells out there. As a matter of fact, I don't think I have ever seen Chemical Process

treat a well other than if I happened to be treating a well on one location and they were on another, I might observe them tied into a well, but I have never gone and watched them treat a well.

Mr. Lyon: I would like to offer this advertisement—this article—if it is an advertisement, I suppose all these articles are written for the purpose of stimulating business, your Honor—I would like to offer this article of the Chemical Process Company, which I have identified, which was published in the Oil & Gas Journal of May 19th, 1938. The witness' Exhibit 327 was published the following September. I offer this to show that similar advertisements, similar articles had been published by others before the witness' article was published.

Mr. Owen: I object to the exhibit.

The Court: If they support theirs by testimony, and if they brought the data sheets in, why—

Mr. Lyon: I am not offering this to prove the facts stated. But I am offering to prove that such an advertisement was run by a competitor—that such an article was written and published in the same magazine before their article was.

Mr. Owen: I object to that as irrelevant and immaterial, your Honor.

The Court: I will let you mark it and put it in. I do not know what use I can make of it. We will call it DX-332.

(The document in question was thereupon marked Defendant's Exhibit No. 332.)

The Witness: The Hugoton field that that article talks about is entirely separate from the Texas Panhandle gas field. It is approximately 90 miles distant. It is a slightly different producing formation, different structure. The Hugoton field is, if I remember correctly, slightly deeper.

In these treatments which are set forth on Exhibit 329, we employed in acidizing those wells, either AD or A, I don't know which. I don't know what the material was that constituted the inhibitor.

Referring to those wells in Kansas in September, 1936, which are listed on Exhibit 331, I was not there when those jobs were done. All I know about that is what I found in the records, except that I happened to be in Kansas during September of 1936, and I knew that we were having this type of work done. I was not personally present on those particular jobs that are included on this list. I don't know of my own knowledge about these times. I took them off some records in Tulsa. I have not had custody of those records since 1936; that hasn't been my job, to keep those records. All I know about what inhibitor was used in those 97 jobs that are referred to on Exhibit PX-331 is what I told you before.

The Court: What are these numbers that are omitted from PX-331? You started in and I find 1802, 3, 4, 5, and 1806 are missing. A. That would be either some other type of formation or some other type of treatment, that is other than Arbuckle dolomite. We are trying to compare this on one particular formation so that the wells would be more or less uniform.

By Mr. Lyon:

Q. You go down to No. 1831, and then the next number is 1848; there were 15 jobs between those numbers; what were those jobs? A. I don't know.

The Court: There are individual ones omitted. 1821 isn't there. A. Oh, yes, lots of them.

The Court: 23. All the way along they are omitted.

By Mr. Lyon:

Q. What do you mean that these are consecutive? A. They are consecutive Arbuckle dolomite wells. There are all kinds of producing formations in Kansas, and we just picked one particular producing section so it would be more comparable.

The Court: When did you select those? A. Since this trial started last July.

The Court: If you used other kinds, what kind of showing would you make? A. I have no idea, your Honor. I asked the office in Tulsa to send me approximately 100 con-

secutive dolomite treatments during this period. I could not answer that question.

I do not know that these omitted ones are not dolomite treatments. I requested this and this is what they sent me. I asked them for approximately 100 consecutive dolomite treatments. The Arbuckle dolomite is noted for its low initial permeability. I do not think that these treatments on that dolomite show an extreme example of taking a long time to get the acid to penetrate the formation and leave the tubing. I think it is a good representative showing of tight wells that we encounter in treating in several areas. As to whether this is unusual, this is as high as any. I can't answer definitely. It is high, yes. It is high. But you will notice here that the range goes from fifteen minutes—I believe I am correct in that—

The Court: Have you got a copy of your letter in which you asked for what you wanted? A. I telephoned.

The Court: Did you tell him what you were trying to prove and what the other side was claiming, so he would kind of know what he was looking for? A. In this conversation I told him I wanted approximately 100 consecutive dolomite wells, and I explained to him that I wanted the records themselves so that I could compute the treating time.

By Mr. Lyon:

Q. Didn't you want him—didn't you tell him you wanted to get a selection that would give you an average time of about seven hours? A. No, I did not.

Q. Well, these columns that are headed time, total time in hours that the acid was in tubing, or total acid—total time acid was in tubing in hours, that doesn't mean that the total amount of acid was in the tubing that length of time, does it? A. In order to figure that, you have to have some index point. And that is where—the index was taken as the bottom of the tubing, and the time was figured from the time that the acid was lowered to the bottom and until it was flushed out of the tubing. That means that that one particular portion of the tubing was in contact with the

acid for that period of time. As to whether that means that all of this acid that was used in that operation was acting on that point of the tubing for that full length of time, it means that that point was in contact with the acid for that period of time. I do not know how to explain it in any other way. Your acid is moving down the tubing, and that point was in contact with the tubing. 1089 gallons of acid was employed in these jobs, on the average, and the average tubing depth was 3211 feet. As to how much acid that tubing will hold it all depends on the size of the tubing. I can give you the figures for this, that is, the 3-inch tubing holds 8 barrels per thousand feet; the 2½ inch tubing holds 5.7 barrels per thousand feet; the 2 inch tubing holds 4.8 barrels per thousand feet. There are 42 gallons in a barrel, and in that depth for 2½ inch tubing, it would be about 19 barrels, and that figures out about 1550 gallons. You could put 1500 gallons in a 2½ inch tubing that deep.

I have no idea what these times would be if I had these other omitted treatments here, had those included in the average. It might be higher, or it might be lower. As to what those other wells were that were omitted, all I know is that we were treating the formation known as the Chat, and we were treating the Viola, the Simpson, and the Mississippi Lime, and several other formations. We then used practically the same type of pump that we now employ.

By Mr. Lyon:

Q. I notice Mr. Chapman says in his write-up, Defendant's Exhibit 332:

Reading: "Although the pumps used in acid work are extremely efficient with regard to high volume and high pressure, operators generally favor the multi-pump hookup. On large acid shots, two or more pumps are used to inject the acidulated fluid into the wells. Recently a well was treated in Young County, Tex., with 20,000 gallons of acid. This acid charge was followed with an oil load of 230 bbls. Ten pumps were connected and delivered fluid simultaneously. The overall treating time on this well for the acid and oil load was 59 minutes." Now, have you done the

same thing in your work? A. I have never hooked 10 pumps up. The most I have ever used was three pumps.

Q. Well, what would be the average time that the acid would be in the well—I mean in the pipe in these 97 jobs reported on PX-330, if you omitted the ten per cent of the jobs which were the highest jobs? A. Well, there are some figures here on the back; 18 treatments were 12 hours or over, or 14.75 per cent of the total; 35 treatments were 6 hours or over, or 26.68 of the total.

Q. Well, that doesn't add up to anything; I say suppose you just take—how many of these treatments are above 25 hours, let's go through; you have said the average is 7, let's go through, there is one at 53, No. 1, one at 33, that will be 2, one at 29 would be 3, one at 55 would be 4, one at 36 would be 5, and one at 43 would be 6, one at 27 would be 8, another 27 would be 9, one at 29 would be 10, one at 31 would be 11, one at 46 would be 12, one at 31 would be 13, one at 33 would be 14. Now, I suspect if you take those 14 out of that that you have averaged in with those 97, your average time in this thing, instead of being 7 hours would be under an hour. Just look at that and see if you don't think so? A. Well, it is obvious that it would reduce it, but I don't know—

Q. Most of these figures run around, some of them half an hour and some of them one hour and one hour, one hour?

The Court: One fifteen minutes.

By Mr. Lyon:

Q. Yes. Now, if you would take these fifteen out of here, or fourteen out, what kind of a time are you going to get? A. Well, I would have to total it up and divide it out in order to answer that question correctly. Offhand, it looks like you would reduce down to in the neighborhood of 3 hours.

Q. Well, we can all do that, I suppose. Now, you don't know whether the actual times of treatment for these wells, intermediate wells, or intermediate treatments, that are not reported on this sheet, are longer or shorter than those that are reported? A. No, I don't know.

These omitted wells in this series which is reported on PX-330 were in different formations, assuming they carried out my request. I asked for Arbuckle dolomite wells, for the reason I gave you a moment ago, it is noted to be of extremely low permeability initially. As to what formations were treated in the treatments that are omitted in the series that is noted on this Exhibit PX-330, I stated that a moment ago, that they would possibly include the Simpson and the Viola and Chat and Mississippi limestone. The Chat formation will treat a little bit easier than the dolomite. It is a little more highly reactive, and while the well may be tight to start with it shows a fairly rapid decrease in resistance to flow after the treatment progresses. The Simpson will vary depending on the locality. It may be the Simpson formation will be harder to treat than a dolomite, but it is highly variable. The Mississippi limestone is another highly variable. Some of those wells are extremely low initial permeability, and don't increase in permeability very rapidly as you progress with the treatment. The Viola is in the same class as the Chat, namely, that it increases.

By Mr. Lyon:

Q. You have referred to the cost of a tubing job as maybe being about $85. That would be high for many tubing jobs and low for others, wouldn't it? A. That is right.

Regarding the price that the operator has to pay for an ordinary acidizing job, the minimum price for a 500-gallon job is $175. I believe that that was the price in 1936. For a 1,000-gallon job the price is $250. That includes the base service price, and then after you use higher gallonage, the price goes down proportionately. After you have used 1,000 gallons, the next 1,000 does not cost as much. For a 2,000-gallon job it is $250 for the base service charge, for 1,000 gallons, and then 18 cents a gallon thereafter for the additional acid up to 5,000 gallons. An approximate figure for the average amount of acid on the jobs that are performed by our company, I would say would be between 3,000 and 4,000 gallons. A typical job

of acidizing that is done by our company is not on an old well, that is producing maybe one or two barrels of oil a day, for the purpose of increasing it to three or four barrels a day. The trend has been in recent years to acidize new wells on completion. However, we still acidize quite a few old wells.

Q. It would be safe to say that you would not be in business, you couldn't afford to operate if what you were trying to do and the only business you had was trying to increase old wells that were down to one or two barrels a day, or three or four, up to maybe three or four times that? If that were the only possibility in the wells you would not be in business, would you? A. The answer is obvious that you wouldn't. It is a matter of economics there, and you have to qualify that by assuming the price of the oil is low.

Q. In other words, people couldn't afford to spend $300 or $400 for an acidizing job on the kind of wells that I mentioned? A. Well, it is purely a matter of economics, and if you can get a five-barrel increase in production that will stay up and maintain a five-barrel increase in production for a long period of time, then it is possible that that might pay a rather high rate of return on a relatively low investment. In other words, there is lots of people will invest $200 to get $5.00 a day back for a considerable length of time.

Q. Well, you couldn't depend on that kind of wells to run your business, could you? That is obvious? A. Well, I think the answer is "no" to that.

I do not intend by my testimony here about the cost of pulling a string of tubing, that the judge should understand from my testimony that an acidizing job is prohibitive if it is necessary to pull a string of tubing in connection with the acidizing job. Our acidizing jobs sometimes involve pulling a string of tubing, depending upon the type of treatment. Our acidizing treatments where we use an acid jet gun require the pulling or the reinsertion of a string of tubing. An acid jet gun is a tool that we have

developed to impinge acid at high velocities against the formation, and take advantage of the erosion effect which you get from impinging the acid at high velocities in conjunction with the chemical effect that you get. The acid jet gun consists of a metal tube that has jets placed in it, 1/16th of an inch jets placed in it, 120 degrees apart, and around the barrel, one foot apart, up and down the barrel.

In using the type of tool I described it is necessary to make a special tubing run to get the tool in and to remove the tool it is necessary to pull the tubing out, but to eliminate that procedure we have developed a jet gun that we run inside the tubing and eliminate that. We did use the tool making special tubing runs commercially and charged for it and did quite a business with it, but it proved to be awkward and so we developed this other one.

As to what other types of acidizing operations where you have to pull or run a string of tubing, if you are going to use a packer to confine your acid to a certain section, if the packer wasn't a part of the well before hand, you would have to pull the tubing and put a packer on. Relatively few of the treatments are made that way. It is not an uncommon thing to do in the business of our company. It is done a good many times over the course of a year.

Q. And in all those cases you have to run a special string of tubing and remove the tubing at the end of the acidizing operation? A. It is not a special operation—it is just the tubing with a packer on it.

That is all the situations, types of acidizing jobs, done by our company in which we have to make a special tubing run that I can think of right now, other than the kind where the operator wants to clean out his well before acidizing, but we do not have anything to do with that.

Q. Well, isn't it perfectly obvious to you that if there was no other way of doing it, that acidizing would still be worthwhile, or worth enough to your customers to warrant their making a special tubing run? A. Why, in the developed state that it is now, I would say "Yes."

Q. Isn't it true that in oil field operations the common practice is, for one reason or another, to pull the tubing in the well every few months, irrespective of any acidizing; I mean even if there is no acidizing involved? A. Well, that of course depends upon the field conditions or well conditions. In fields that have paraffin troubles, why, they will pull tubing; sometimes they have to pull the tubing to remove the paraffin. They certainly do pull tubing and replace it occasionally in wells when they do not pump right.

RE-DIRECT EXAMINATION

I stated that I took up my duties as station manager at Borger, Texas, and the Texas Panhandle, some time in July of 1937. I do not recall that Chemical Process Company had treated any gas wells with acid in the Texas Panhandle territory prior to my going there in July of 1937 as station manager. I knew that they were operating in the Hugoton area, which is removed eighty or ninety miles from there. Our first treatment in that field using this method, according to my tables, was May 10, 1937.

When you use the jet gun in acid treatments, you must pull the tubing and put on the gun, run it back in, pull the tubing and take the gun off. The gun is so constructed that you can produce fluid if you want to leave it in the well. You have got to make two round trips to recover the gun.

HEITHECKER STIPULATION

(Offered on behalf of plaintiff.)

It is stipulated by and between counsel for the respective parties that if R. E. Heithecker were called by plaintiff and sworn as a witness he would testify as follows:

I am a resident of Bartlesville, Oklahoma, and my address is care of the Bureau of Mines in that city. My education and experience include a Bachelor of Science degree in Mechanical Engineering from Purdue University, in June, 1924, employment in the production, refining, gasoline and purchasing departments of Empire Companies (now Cities Service Company), Bartlesville, Oklahoma, from July 1, 1924, to October 1, 1926, and employment by the United States Bureau of Mines continuously since October 2, 1926.

The Bureau of Mines was established by Organic Act of Congress (36 Stat. 369) approved May 16, 1910, effective July 1, 1910, and amended by an Act (37 Stat. 681) approved and effective February 25, 1913. An Act (40 Stat. 469) approved March 3, 1915, authorized the Secretary of the Interior to establish and maintain mining experiment and mine safety stations under the Bureau of Mines. In 1917 the Secretary of the Interior designated that one of the experiment stations should be devoted exclusively to petroleum and natural gas, and in 1918 the Petroleum Experiment Station was established in Bartlesville, Oklahoma.

My work with the Bureau of Mines has been in accordance with the provisions of the above acts and has included assignments as follows: In Laramie, Wyoming, from October 2, 1926, to July 1, 1927; in Bartlesville, Oklahoma, from July 1, 1927, to December 1, 1928; in Carlsbad, New Mexico, from December 1, 1928, to June 5, 1930; in Shreveport, Louisiana, from June 5, 1930, to March 15, 1933, and in Bartlesville, Oklahoma, from September 1, 1933, to the present. My work under said assignments has been on

problems relative to Petroleum and Natural Gas, and for a while on the drilling of potash wells in West Texas and New Mexico.

I am the author of Bureau of Mines Reports of Investigations No. 3251, published October, 1934, entitled "Engineering Studies and Results of Acid Treatment of Wells, Zwolle Oil Field, Sabine Parish, La.," and No. 3445, published April, 1939, entitled "Effect of Acid Treatment upon Ultimate Recovery of Oil from some Limestone Fields of Kansas."

As stated in the acknowledgments of these reports, the contained data were collected by me and under my supervision from the records of oil companies, acid treating companies and state oil commissions, including reports of production filed by oil producers in accordance with the requirements of Federal and State Statutes and Executive Orders. Before publication the reports were read, criticised and approved by engineers and officials of oil companies, acid treating companies and State Oil commissions as well as by the engineers of the Bureau of Mines, and the statements contained in both said reports are true and correct to the best of my knowledge and belief.

Mr. Conner: I offer in evidence as PX-69 the report of investigations by Mr. Heithecker which is No. 3445.

(The report of investigations No. 3445 referred to was thereupon marked as Plaintiff's Exhibit 69.)

Mr. Conner: Likewise I offer in evidence as PX-70 the report of investigations No. 3251 by Mr. Heithecker.

(The report of investigations No. 3251 was thereupon marked as Plaintiff's Exhibit 70.)

Mr. Lyon: We object to those, your Honor, on the ground they are hearsay and incompetent as proof of the statements of fact contained in the reports. They seem to be based on information obtained by Mr. Heithecker from other parties, and the other parties are not here to be cross-examined. They contain many matters of opinion, as well as purported statements of fact.

The Court: I think I should stick pretty closely to the

rule as to hearsay. All things of that kind ought to be considered with great care, in this court and all courts. So it doesn't come here in this court with any absolute presumption that they are right, I will tell you that.

The Court: I will admit these exhibits. I don't accept them as binding on this court as to what they say.

PX-69, Bureau of Mines Report on "Effect of Acid Treatment upon the Ultimate Recovery of Oil from Some Limestone Fields of Kansas," published in April, 1939, is in part as follows:

"INTRODUCTION

"In Kansas, almost every oil well drilled into a limestone formation is treated with hydrochloric (muriatic) acid upon completion. This is done to increase the potential capacity of the well and thereby increase its 'daily allowable' production (see p. 9), to shorten the time required to produce the recoverable oil, and to increase the quantity of oil recovered ultimately from the reservoir. The porosity and permeability of limestone formations seldom are uniform throughout the proved area, consequently the production capacities of completed wells vary considerably. Acid treatment of wells tends to increase production capacity and to equalize potential capacity." (Page 3.)

"If offset wells already have been treated with acid, new wells usually are treated to protect the property on which they are drilled against drainage. Even though competitive conditions do not exist in a field, it is generally assumed that the higher 'allowable' resulting from acid treatment will justify the additional cost of completing a well with acid." (Pages 3 and 4.)

"Acid treatment of wells also may be credited with extending the productive limits of some limestone fields in Kansas. Edge wells, which showed only small, non-commercial quantities of oil, have been completed as large oil wells after acid treatment, either alone or after being shot with nitroglycerin." (Page 4.)

"Acid treating marked an advance in the producing history of limestone fields of Kansas; in fact, many old limestone fields that almost had reached their economic producing limit were 'rejuvenated' and their capacity to produce increased several times. In the Fairport field (Russell and Ellis Counties), for example, production had declined to a daily average of about 10 barrels per well, and it was unprofitable to continue to produce many of the wells. After the wells had been treated with acid, the production per well averaged over 30 barrels per day for a year, even though the production was party curtailed through proration restrictions. The rejuvenation of the Arbuckle limestone wells of the Eldorado field, Butler County, is another example of the benefits derived from acid treatment. Many wells that had produced for 13 to 15 years and had about reached their economic limits were rejuvenated through the use of acid and continued to yield large quantities of oil." (Page 4.)

"Limestone structures that had been tested by drilling and found noncommercial were completed later as commercial oil-producing formations through the use of acid. The original development of the Kansas City limestone at Valley Center, Sedgwick County, yielded very few commercial wells, although enough oil showings were noted during drilling to deeper levels to indicate that oil was present. Evidently the low permeability of the Kansas City limestone prevented many of the wells from becoming commercial producers from this formation. After the deeper reservoir had been depleted of its economically recoverable oil, many wells were plugged back to the Kansas City formation and were made good producers by the use of acid." (Page 4.)

"Hydrochloric acid was used to treat oil wells in Kansas for the first time in October 1932. Treating programs were soon inaugurated by various oil companies; by the end of 1934, 944 wells had been treated and by the end of 1937, 5,824 wells. The total number of acid treatments given to wells in Kansas by the end of 1937 was 8,070, because many

wells had been treated more than once. These treatments consumed approximately 12,750,000 gallons of acid. The cost of the service to the operators is estimated at about $2,500,000." (Page 4.)

"ACKNOWLEDGMENTS

"The writer wishes to acknowledge the interest and assistance of the acid-treating service companies and of many oil companies for the generous use of their files on the acid treatment of wells in Kansas.

"Production statistics of individual wells, groups of wells, leases, and entire fields were compiled from oil-company records and from the reports of the Kansas State Corporation Commission. Well-completion records for the State were taken from the Oil and Gas Journal.

"This investigation was made under the general supervision of R. A. Cattell, chief engineer, Petroleum and Natural Gas Division; N. A. C. Smith, supervising engineer, Petroleum Experiment Station; and under the immediate supervision of W. B. Berwald, senior petroleum engineer, Bureau of Mines. C. F. McCarroll, C. R. Bopp, W. F. Krueger, and E. M. Tignor, of the Bureau of Mines, assisted in compiling the production statistics and treating records. The illustrations were traced by R. C. Wright and R. M. Himmelright.

"The writer is indebted to the following for constructive criticism of the report: L. C. Morgan, Morgan Acid, Inc.; B. M. Kingston and M. E. Chapman, The Chemical Process Co.; C. E. Clason, Halliburton Oil Well Cementing Co.; John G. Staudt and P. E. Fitzgerald, Dowell Incorporated; W. H. Burke and C. H. Keplinger, Shell Petroleum Corporation; A. W. Walker, Stanolind Oil and Gas Co.; E. O. Bennett, Continental Oil Co.; A. J. Lewis, Central Petroleum Co.; W. B. Lerch, Phillips Petroleum Co.; Sam Harlan and N. M. Hutchinson, Cities Service Co.; E. L. Rawlins, Union Producing Co.; E. G. Dahlgren and J. H. Page, State Corporation Commission of Kansas; Marvin

Lee, Petroleum Geologist, formerly with the State Corporation Commission of Kansas; and W. B. Berwald, H. C. Miller, N. A. C. Smith, C. C. Anderson, Charles B. Carpenter, H. D. Nichols, and C. F. McCarroll, all of the Bureau of Mines.

"The investigation was carried on in cooperation with the Kansas State Corporation Commission." (Pages 5 and 6.)

"SCOPE OF REPORT

"To ascertain the effects of hydrochloric acid upon the ultimate economic recovery of oil from limestone reservoirs, it was necessary to investigate the effects of acid upon the oil reservoirs from old, depleted, or almost depleted fields, individual leases, and groups of wells." (Page 6.)

"Studies were made of the production records and production-decline curves of the wells in the Fairport field, Kansas, and one 80-acre lease in that field was studied in detail. The records of three groups of wells in the Eldorado field were examined to estimate production trends before and after acid treatment. The wells were producing from different horizons, and from the estimates of production trends the net effects of the acid on oil recovery were calculated. The records of wells in the Kansas City formation at Valley Center also were studied. Many wells were plugged back from a deeper pay, and the upper horizon was treated to obtain commercial production. Production records of the Shutts field also were examined." (Page 6.)

"Acid-treating records from the various acid-service companies operating in Kansas and those from most of the oil companies that treated some of their own wells were tabulated and classified. It is believed that the records of more than 95 per cent of the oil wells treated in the State to the end of 1937 were available for tabulation." (Page 6.)

"ACID TREATMENT OF WELLS IN KANSAS

"Kansas oil wells were first acid-treated to increase production late in 1932, and the early treatments were very successful. Extensive acid-treating programs soon were initiated by many operators, both in old and in flush producing areas, and at present acid treatment of wells has become so general that few wells are completed in limestone formations without its use." (Page 10.)

According to the records of acid treatments, 5,824 wells in Kansas were given a total of 8,070 treatments to the end of 1937. In all, approximately 12¾ million gallons of acid were used. * * *" (Page 10.)

"FIELD STUDIES

"The use of acid has increased the production rate of many new wells that produce from limestone formations in Kansas, but it is seldom possible to forecast ultimate yields and to demonstrate that acid treating has increased them. For new wells, however, that would have been nonproducers if they had not been acid-treated, the entire recovery may be classed as increased yields. Other wells have been plugged back to formations that previously had been tested and found noncommercial and then treated with acid. Production from such well also may be classed as increased recovery." (Page 12.)

"Oil production for the (Fairport) field reached a minimum in May 1933 shortly after the initiation of acid treatment, when 36,456 barrels of oil were produced from 123 wells, an average of 10 barrels per well per day. In November 1933, just 6 months later, the field reached a new production peak of 140,490 barrels of oil from 125 wells, an average of 37 barrels of oil per well per day. Since then the output has declined, although additional wells were drilled and several wells that had been abandoned temporarily were put back into production. In June 1938, 145

wells produced 59,869 barrels, an average of 14 barrels per well per day." (Page 14.)

"ACID TREATMENT

"The first acid treatment of an oil well in the Fairport field was made in January 1933. Its success led to the treatment of other wells, and by the end of 1933, 95 wells had been treated. Second 'shots' of acid were given to only four wells during 1933, but during 1934 many wells received second and third treatments of acid. By the end of 1937, 260 acid treatments had been given to 175 wells, one well having been treated five times. A summary of acid treatments of wells in the Fairport field is tabulated in table 3 and shown graphically in figures 4 and 5." (Page 15.)

"STUDY OF ACID TREATMENT ON AN 80-ACRE LEASE IN THE FAIRPORT FIELD

"The beneficial results of acid treatment on wells that had been abandoned or that were about ready for abandonment is shown by the study of an 80-acre lease in the Fairport field. Because of its favorable position on the producing structure, this lease probably is one of the best of the field. Eight producing wells were completed on the lease between June 1924 and February 1926 with a pattern of 10 acres per well." (Page 15.)

"In 1932, the year previous to acid rejuvenation, the lease produced 12,622 barrels of oil, an average daily output per well of 4⅓ barrels. The daily average production of oil per well increased to over 7 barrels in 1933 and to 22 barrels in 1934, then declined to 12 barrels in 1935 and to 6½ barrels in 1936. It increased to slightly over 7 barrels per well in 1937. The quantity of oil produced in 1934 compared to that in 1932 represented an increase of over 400 per cent." (Page 15.)

"* * * At the time of production test before acid treatment, 1 well was temporarily shut in and the others showed a capacity of only 2 to 7 barrels of oil daily. After acid treatment the wells tested 30 to 108 barrels of oil a day. The first well treated on the lease tested 2 barrels of oil daily before treatment and 108 barrels after treatment on January 22, 1933. No other wells on the lease were treated until November 1933, so the increase in production of oil during most of 1933 probably was due to the increase from this well. Acid treatments in other wells on the lease in November 1933 and in the early months of 1934 increased the lease output to over 5,000 barrels of oil per month for about 1 year before a decline began. In November 1934 the lease produced 6,736 barrels of oil, a daily average per well of 28 barrels. During this period, the entire field output was curtailed through proration restriction. The 24-hour potential for the lease during the greater part of 1935 was 253 barrels but dropped to 83 barrels in December. In June 1936 it was raised to 107 barrels; later in the year it was lowered to 75 barrels, holding that figure until proration was lifted in August 1937." (Page 17.)

TABLE 4.—Acid Treatment Data on 80-Acre Lease[1/] in Fairport Field, Russell County, Kans.

Well No.	Date Completed	Initial Production, bbl./day	First Treatment Record						Second Treatment Record					
					Daily Production, bbl.						Daily Production, bbl.			
			Date	Gallon Acid	Before Oil	Before Water	After Oil	After Water	Date	Gallon Acid	Before Oil	Before Water	After Oil	After Water
1	June 1924	1,000	1-22-33	750	2	½	108	1						
2	Sept. 1924	125	4- 6-34	1,000	2	3	40	15	11–4–35	2,000	2	5	20	5
3	Jan. 1925	125	4-18-34	1,000	5	3	65	5						
4	Mar. 1925	210	1- -34	1,000	4	2	50	5						
5	Mar. 1925	350	2- 3-34	1,000	[2/]0	0	75	70	1–14–35	1,000	23	21	23	21
6	May 1925	375	11- 2-33	1,000	6	1	[3/]30	—						
7	June 1925	300	6-11-34	1,000	5	15	60	20	9–5–34	1,000	20	19	90	10
8	Feb. 1926	168	1- 2-34	1,000	7	3	50	?						

[1/] Courtesy Central Petroleum Co., Tulsa, Okla.
[2/] No test, well had been shut in.
[3/] Increased to 90 barrels per day after 2 weeks.

(Page 18.)

"The indicated decline of oil production of the lease was rapid from February, 1935, to July, 1935. The percentage allowable for the Fairport field was reduced monthly from approximately 75 per cent of the potential rating in March 1935 to 22 per cent in October 1935. In spite of this decline, the production of the lease from July 1935 to July 1938 ranged from 1,033 to 2,518 barrels of oil monthly, which was more than it produced during the year 1932 before the wells were treated." (P. 19.)

"The cumulative production of oil at the end of 1932 was 613,277 barrels for the 80-acre lease—a recovery of 7,666 barrels of oil per acre. At the end of 1937 it was 775,325 barrels—a recovery of 9,690 barrels of oil per acre. Taking into consideration the rate of decline during the period 1927-1932, it has been calculated that by the end of 1937 the total production would have been approximately 655,000 barrels of oil if acid had not been used. Therefore, acid treatment of the wells may be credited with a net gain of at least 120,000 barrels of oil for the lease to the end of 1937, or 1,500 barrels per acre more than would have been possible under ordinary methods of production." (P. 19.)

"EFFECTS OF ACID TREATING IN FAIRPORT FIELD

"The effects of well rejuvenation due to acid treatment are evident in the oil-production figures for the Fairport field. The total cumulative oil production at the end of 1932 was 7,956,263 barrels, and the well average had dropped to 12 barrels per day. If acid had not been used it is doubtful whether any of the 'temporarily abandoned' wells would have again produced oil or whether there would have been any additional drilling in the field. Considering the rate of oil-production decline from 1929 to the end of 1932, it was estimated that the quantity of oil that would have been produced from 1933 to 1937 would have been approximately 2,450,000 barrels. The actual production through the 5-year period 1933-37 was 4,956,082 barrels,

making a net increase of approximately 2,500,000 barrels of oil. If it is assumed that no new wells would have been drilled or old wells returned to production after 1932, when acid treatment methods were introduced, the increase of 2,500,000 barrels for 125 wells is approximately 20,000 barrels of oil per well to the end of 1937. It was also estimated from the production-decline curve for 1933-37 that by about 1940 production will have declined to the average for 1932 but will not reach the older extended decline curve (1929-32) until later. From these decline curves it was estimated that during the 5-year period 1938-42 approximately 1,000,000 more barrels of oil will be produced than if acid had not been used in the Fairport field. This quantity added to the 2,500,000 barrels makes a total increase of approximately 3,500,000 barrels to the end of 1942. Considering 3,600 productive acres in the Fairport field, this quantity represents an increase of approximately 1,000 barrels of oil per acre due to acid treatment." (Pages 19, 20.)

"ACID-TREATING INVESTIGATION IN THE ELDORADO FIELD

"The investigation of acid-treatment records in the Eldorado field did not include all the treatments by the different companies in all the producing horizons of the field because not enough data were available for such a study. However, the records of 266 treated wells were made available for study. These produced from three zones—the Arbuckle (Siliceous) Viola-Wilcox, and Lansing limestones." (Page 22.)

"OIL PRODUCTION

"The estimated production records of 138 wells producing from the Arbuckle (Siliceous) limestone formation which were treated with a total of 229 treatments (an average of 1 2/3 treatments per well) were tabulated and plotted. * * *" (P. 23.)

"Using the rate of production decline from 1924 to 1932, graphic calculations showed that from 1933 to 1937 approximately 667,000 barrels of oil would have been produced if acid had not been used. As 2,457,000 barrels of oil were produced during this 5-year period, there was an increase of 1,790,000 barrels of oil due to acid treatment of the 138 wells to the end of 1937, an average net increase of approximately 7 barrels per day per well over the 5-year period." (Page 23.)

"A large number of wells in the Eldorado field produce from both the Viola limestone and 'Wilcox' sand." (Page 24.)

"The records show that 77 wells producing from the Viola-Wilcox formation were treated 106 times with acid—an average of 1⅓ treatments per well." (P. 24, 25.)

"As a result of acid treatments of wells in the zone, the average production per well increased rapidly during 1933 from 330 barrels per month in February to 690 in December. From the peak reached in 1934, production began to decline gradually. It was estimated graphically, that approximately 1,185,000 barrels of oil would have been produced from this group of wells during 1933 to 1937, inclusive, assuming normal decline of production rates. However, as 2,324,530 barrels of oil were produced during this period, there was a net increase of approximately 1,140,000 barrels to the end of 1937, an average net increase of approximately 8 barrels per day per well over the 5-year period." (Page 25.)

"Forty-nine wells producing from the Lansing formation and two wells producing from the Kansas City limestone (which in the discussion are classed with the Lansing) received 91 treatments, an average of 1 4/5 treatments per well." (Page 25.)

"Using the rate of oil-production decline during 1930-32, graphic calculations showed that from 1933 through 1937 approximately 446,000 barrels of oil would have been produced if the wells had not been treated with acid. As 915,782 barrels of oil were produced during the 5-year inter-

val, the net increase of approximately 470,000 barrels to the end of 1937 resulted from the acid treatment of the 51 wells, an average net increase of approximately 5 barrels of oil per day per well over the 5-year period." (Page 26.)

"SUMMARY OF ACID TREATING IN THE ELDORADO FIELD

"Apparently acid treatment of wells in the Arbuckle (Siliceous), Viola-Wilcox, and Lansing limestone formations in the Eldorado field has increased the ultimate economic recovery of oil from these formations. It was estimated that at the end of 1937 1,790,000 more barrels of oil were produced from the Arbuckle wells than if the wells had not been treated with acid. By the end of 1942 these wells will have produced an estimated 2,690,000 barrels of oil in excess of their estimated production without acid treatment—a net increase of 19,500 barrels per well from 138 wells. This represents approximately 2,400 barrels per acre." (Page 26.)

PX-70

PX-70, Bureau of Mines Report No. 3251, entitled "Engineering Studies and Results of Acid Treatment of Wells, Zwolle Oil Field, Sabine Parish, La.," is in part as follows:

"ACKNOWLEDGMENTS

"Grateful acknowledgment is made to J. A. Shaw, director, N. V. Kinsey, former field agent, and C. P. Dunbar, all of the Louisiana Department of Conservation, as well as to the oil companies and their personnel, who have contributed well records, production data, and geological information. Credit is due the following men for their interest and assistance in the various phases of the work: R. T. Hazzard, G. W. Schneider, W. C. Spooner, H. D. Easton, Wayne Jones, S. A. Thompson, C. L. Moody, R. L. Gay and

associates, H. E. Sullivan and assistants, E. B. Hutson, and R. D. Norton. Thanks are extended to the Standard Pipe Line Co. for production statistics and to the Gulf Refining Co. of Louisiana and the Ohio Oil Co. for well elevations.

"Acknowledgment is made to Dowell, Inc., and to the Ricou Corporation for their interest and cooperation in supplying valuable information and records showing the results of acid treatment on production. H. K. Shearer, engineer and geologist of Shreveport, La., supplied production data and information on the results of treating wells with acid, especially those operated by the Pelican Natural Gas Co." (Page 1.)

"The report was criticized by H. C. Fowler, R. A. Cattell, and H. B. Hill, of the Bureau of Mines; R. T. Hazzard, Gulf Refining Co. of Louisiana; and C. L. Moody, Ohio Oil Co. The part of the report regarding acid treatment was criticized by H. K. Shearer, Pelican Natural Gas Co.; by N. A. Best, Dowell, Incorporated; and by Ludwig Schmidt and John M. Devine, of the Bureau of Mines." (Page 2.)

"GENERAL STATEMENT

"The Bureau of Mines began an engineering study of the Zwolle oil field in June 1930 at the request of the operators and of the Louisiana Department of Conservation. Following the usual procedure in making reports on other fields geological and production data were collected. Special attention was given to obtaining information which might indicate the conditions controlling accumulation of oil in this chalk-rock field. Information also was obtained on development methods and production practices." (Page 2.)

"The pay formations in the Zwolle field are favorable to treatment with acid because of the character of the reservoir rock, which consists of chalks, marls, and limestones that dissolve readily in an acid solution. Many wells with small initial production or with favorable shows have been reconditioned by acid treatment and completed as com-

mercial producers. Treatment of these wells with acid apparently has opened and enlarged existing, minute channelways connected with oil-bearing cavities in the chalk which readily give up the oil through the newly opened drainage channels." (Page 27.)

"PREPARATION OF ACID OR SOLVENT

"Hydrochloric acid of approximately 15-percent strength, to which certain inhibitors had been added to prevent corrosive action on well equipment, was used for treating wells in the Zwolle field. The raw acid, of 19.2° B. (1.1526 specific gravity) and 30-percent strength was shipped to the field station in rubber-lined tank cars. The inhibiting chemicals were added and mixed at the field stations while the acid to 15 percent was being diluted; the resulting solvent, of 1.07 specific gravity was stored in steel tank cars or tanks.

"The corrosive activity on metal equipment of the acid solution when properly mixed with inhibitors has been studied in detail and discussed in published articles.* For proper protection of well equipment the acid should be inhibited sufficiently to allow storage in steel tanks with a minimum of corrosive action. In treating the average well in the Zwolle area the solution is in contact with well equipment a relatively short time, and the complete operation requires only about 2 hours. Proper inhibition is a safety measure and protects the equipment against unforeseen delays which may arise during the treatment of wells. (P. 28.)

*Petroleum World, Chemical Treatment of Wells a Major Development: December, 1932, p. 511.

Oil and Gas Journal, Development of Acid Treatment of Oil Wells Involves Careful Study of Problems of Each: Feb. 23, 1933, p. 8.

Petroleum Engineer, Acid Treatment of Oil Wells: April, 1933, p. 24.

Oil Weekly, Acid Treating for Increasing Oil Production: May 29, 1933, p. 18.

"GENERAL PROCEDURE FOR TREATING WITH ACID

"The same general practice was followed by the different contractors in treating wells in the Zwolle field, namely, the solution was pumped into the formation near the bottom of the hole through a string of pipe. In pumping wells the acid solution was pumped down the tubing after removing the sucker rods and standing valve. In other wells either the drill pipe or a string of tubing was used. The procedure is described as follows:

"The casing and tubing (or drill pipe) were filled to the top with oil; the acid pump, mounted on an automobile truck, was then connected to the tubing and the solvent pumped down the hole. When the gage on the acid pump or tubinghead indicated a slight pressure, the valve on the casinghead was 'cracked' to allow the oil to 'bleed' from between the casing and the tubing. A measured amount of oil equivalent to the volume of the tubing plus the volume of the open hole from the bottom of the well to a determined point below the casing seat, was allowed to bleed from the valve; the valve was opened enough to keep the pressure from building up more than a few pounds per square inch, as indicated on the pressure gage. When the predetermined amount of oil had been bled off the valve was closed and the complete acid charge pumped into the bottom of the well. A pressure of 600 pounds per square inch was built up in some of the wells. The speed of the pump was regulated to prevent the pressure from building up higher than 600 pounds per square inch, although the pumping equipment was capable of developing pressures up to 1,500 pounds per square inch. For example, the amount of oil that could be bled from the casing was approximately 16 barrels (672 gallons) in a well 2,500 feet deep, with the casing set at 2,300 feet and equipped with a string of 2-inch tubing. Sixteen barrels is equivalent approximately to two-thirds of the acid charge." (PP. 28, 29.)

"The charge of 1,000 gallons was followed by 10 to 50 barrels of oil, which was pumped down the conductor pipe to displace the solvent and act as a flushing agent to clean the walls of the tubing. Some excess oil was forced into the formation, thus driving the solvent ahead of it. It was the general practice to allow the acid to remain in contact with the formation 48 hours before a production test was made."

"Pressure gages were placed generally on both the tubing and casing-heads. The gage on the tubing in one well under treatment showed a pressure of 120 pounds per square inch compared with a pressure of 375 pounds per square inch on the casing-head. On another well the pressures observed were 400 pounds on the tubing and 650 pounds on the casing. The differences in pressure between tubing and casing recorded in the two wells were 255 and 250 pounds per square inch, respectively. These figures represent approximately the difference in pressures between the 2,500-foot fluid column of acid solution (1.07 specific gravity) inside the tubing and the oil column (0.818 specific gravity) behind the tubing. The pressure at the bottom of the hole was of the order of 1275 pounds per square inch in the first well mentioned and 1,550 pounds per square inch in the second. The gage pressures varied considerably at the different wells, and higher pressures were required in the wells drilled through tight or unbroken strata than in those completed in porous or broken formations. The average time required to pump a 1,000-gallon charge of solvent ranged from 30 minutes to 2 or 3 hours, depending upon the pressures necessary to force the acid back into the formation. Siphoning of the acid solution from the acid truck into the well was observed during the second treatment of the Supreme Oil Co., Pruitt well 1, in sec. 30, T. 8 N., R. 11 W., where a charge of 1,000 gallons was run into the well in twelve minutes." (P. 29.)

"In a letter to the writer H. K. Shearer, engineer and geologist of the Pelican Natural Gas Co., has described in detail acid treatment and results of the treatment of the

Pelican Natural Gas Co., Louisiana Long Leaf Lumber Co. well 16, in sec. 10, T. 7 N., R. 11 W." (P. 29.)

"This well was completed at a depth of 2,627 feet on November 2, 1932, and the casing was set at 2,438 feet. The production for the first day was 60 barrels, then the average daily production ranged from 8 to 12 barrels until December 8, when the well was shut down preparatory to treatment with acid. The rods and standing valve were pulled. The casing and tubing were then filled with 71½ barrels of oil. Sixteen barrels of oil were bled from the casing while the solvent was being pumped into the tubing. The casing pressure 'built up' to 250 pounds per square inch while the acid solution was being pumped into the well, but no tubing pressure was recorded. Following the acid charge of 1,000 gallons, 12 barrels of oil were pumped into the tubing. During this operation a pressure of 150 pounds per square inch was recorded on the tubing, while the casing pressure remained constant at 250 pounds per square inch. After a relatively short time the pressure on the casing and tubing dropped suddenly, suggesting a partial vacuum at the wellhead, as the acid solution flowed into the formation." (PP. 29, 30.)

"The production test began at 3:45 p. m. December 12, about 48 hours after the acid had been pumped into the well. During the first 1½ hours the well pumped 33 barrels; this was followed by 154 barrels in 4½ hours and 376 barrels in 12 hours. The production for the next 24 hours was 666 barrels. The complete production history of this well from the date of completion to January 1, 1934, is given in figure 11." (P. 30.)

"On December 28, 1933 the accumulated production from this well was 110,987 barrels, of which only 336 barrels was produced before acid treatment on December 10, 1932. Assuming that the well would have continued to produce an average of 8 barrels daily until December 28, 1933, it would have produced 2,848 barrels, in addition to the 336 barrels, or a total of 3,184 barrels without acid treatment. The difference between 110,987 barrels and 3,184 barrels is

107,803 barrels, an amount that reasonably may be credited to acid treatment." (P. 30.)

"The increase in production of this well after acid treatment apparently had no appreciable effect on the production of the offset wells. The location relative to nearby wells is shown in figure 11. The unusual increase in production after treatment suggests that a channelway was opened by the acid to an undrained and distinct oil-filled cavity or porous zone." (P. 30.)

"The history of acid treatment of C. H. Tuttle, Byrd No. 3 well, in sec. 7, T. 7 N., R. 10 W., is of interest. The owner and Charles Frink, field representative of Dowell, Inc., gave the writer an account of the treatment. The well was completed September 1932 at a depth of 2,727 feet. The 6-inch casing was set at 2,424 feet. After it had been equipped for pumping the production was approximately 1 barrel of oil per day. The well was treated by the owner with 100 gallons of raw hydrochloric acid without an inhibitor in an attempt to increase production. The raw acid was poured into the tubing and followed by about 50 barrels of oil. A gas pressure of about 60 pounds per square inch was held on the well for approximately 5 days. The treatment resulted in an estimated increase of 8 to 10 barrels per day. In attempting to treat the well later with inhibited acid the tubing was found to be damaged so badly by the treatment with raw acid that it was impossible to pump the inhibited acid into the well under pressure. Some of the acid, however, was forced to the bottom of the hole, and upon bailing some increase in oil was noticed." (P. 30.)

"A new string of 2-inch tubing was run and the well treated the third time. The casing and tubing were filled with oil. The bleeder valve at the casinghead was opened when the acid pumps were started. After an amount of oil equal to the volumes of the tubing and the open hole up to a point near the casing seat had been bled from the casing the valve was closed and the remainder of the acid pumped into the well under pressure. The pressure at the pump immediately built up to 225 pounds, with pressure of 460 pounds per square inch at the casinghead. The acid pump,

was run at full speed while pumping in the remainder of the charge; the pressure at the tubinghead increased to 275 pounds and that at the casinghead to 510 pounds. After approximately three-fourths of the charge had been pumped into the well the pressures dropped suddenly to 125 pounds on the tubing and 360 pounds per square inch on the casing. Following the acid 45 barrels of oil were pumped into the well to flush the tubing and drive the solvent into the formation. The pressures equalized at 300 pounds per square inch on both the tubing and casing heads when the well was closed in for 48 hours. Upon opening for a production test the well began to flow. At the end of the first 12 hours it was producing 38 barrels per hour through a one-eighth-inch choke with 175 pounds back pressure. The choke was adjusted to obtain a production of approximately 200 barrels per day. The 'closed-in' pressure was 700 pounds per square inch. The production from this well declined rapidly." (PP. 30 and 31.)

"RESULTS OF ACID TREATMENT

"An analysis of the production data covering 134 acid treatments in 113 wells showed that the oil production was increased in 62 wells for 30 days or more and that the records of 29 of the wells showed an increase in production of 100 per cent or more for a 30-day period or longer. Forty-one wells, with a combined production of 1,055 barrels per day before treatment, showed a production of 3,902 barrels per day, immediately after treatment, and 2,974 barrels per day after 30 days. The total production of the 41 wells, 30 days after treating, was 282 per cent of the amount before the acid was used. Ten wells had a combined production of 71 barrels per day before treatment, 1,782 barrels per day immediately after treatment, and 1,512 barrels per day (21 times the production before treatment) at the end of a 30-day period. The results of 134 acid treatments are given in table 12." (P. 31.)

* * * * *

"CONCLUSION

"The acid method offers favorable possibilities for reviving oil production, especially in unprofitable pumping wells, and as a 'last chance' in testing 'oil showings' in newly drilled wells. At least a dozen wells in the Zwolle field have been equipped for pumping and placed upon production following the acid treatment that otherwise probably would have been abandoned as noncommercial wells."

"The additional cost of treating a newly drilled well, if warranted by oil showings, does not add materially to the total cost. To January 1, 1934, 623 wells were drilled in the Zwolle area; of this number 361 or 58 per cent were dry holes. Oil showings were recorded in many of these dry holes, some of which might have been treated successfully by acid solution. The seemingly complex reservoir conditions and the irregular occurrences of the oil in the marl and chalk formations preclude definite statements as to the results that might have been obtained in the treatment of the dry holes."

"Although the percentage of oil-well completions in the Zwolle field has remained low since the introduction of acid treatment in December, 1932, the ratio of the number of oil wells completed to the total number of tests drilled has increased from 39.5 per cent for the 13-month period before December 1, 1932, to 47.6 per cent for the 13-month period after December 1, 1932."

"It is possible that the lack of success in some examples of treatment may have resulted from insufficient amount of acid to dissolve the 'limy' deposit on the liner, which in some instances has ranged from one-fourth to three-eighths inch in thickness. It may be advisable to condition wells which are making water for a period of time before treating by pulling the liner and cleaning out the calcareous deposition and sludge material that may have collected in the bottom of the hole before acid treatment, so that the chemical action of the acid will become

more effective in opening new drainage channels or establishing better flow conditions in the old channels after this conditioning."

"In a few wells outstanding results have been obtained by treating with acid. The somewhat spectacular increase in production from these wells has been the stimulus for the general application of the method. It has been used at some time in the majority of the wells."

"At least 150 wells were given 190 acid treatments during the 13 months ended January 1, 1934, at a cost of about $50,000 to the operators. Based on an estimated production of 604,000 barrels of oil due to acid treatment, the return was approximately 12 barrels of oil per dollar expended. During this period the range of the posted price of crude oil was from $0.25 to $1.01 per barrel; and the average, weighted on a daily basis, was $0.66." (P. 35.)

MILLER STIPULATION

(Offered on behalf of plaintiff.)

It is stipulated by and between counsel for the respective parties that if H. C. Miller were called by plaintiff and sworn as a witness, he would testify as follows:

I am a resident of San Francisco, California, and my address is care of the United States Bureau of Mines in that city. I am Senior Petroleum Engineer with the United States Bureau of Mines at San Francisco, and have been connected with said Bureau continuously for the past

sixteen years. I am a graduate of the Michigan College of Mines, now known as the Michigan College of Mining and Technology, and have Bachelor of Science and Engineer of Mines degrees from said college.

I was sworn and testified as a witness at one of the hearings held before a sub-committee of the Committee on Interstate and Foreign Commerce of the House of Representatives of the Seventy-sixth Congress of the United States, held at Washington, D. C., on November 6, 7, 8 and 10, 1939. The following statement appearing at pages 369 and 370 of the Official Report of said hearings, printed by the United States Government Printing Office for the use of said committee, correctly summarizes my said testimony:

"Almost every well drilled into a limestone formation is treated with hydrochloric acid at some time during its pro .ucing life. In areas where daily allowable production per well is based upon the well's capacity to produce and operators desire high initial production rates so that their allowables will be maximum, acid treating usually is part of the well-completion process. In old producing areas, treating wells with acid is for the main purpose of increasing the quantity of oil recovered ultimately from the reservoir. For that reason, wells often are treated with acid at frequent intervals throughout their producing lives.

"Acid treating has had a far-reaching effect on the petroleum industry in that it has effected a complete change of attitude toward limestone production. The spread of development into such limestone areas as western Kansas, Michigan, Illinois, and northern Louisiana may be ascribed in large measure to the success of acid treating processes. Many wells drilled into limestone formations in those areas have been commercially productive of oil and gas only as a result of acidizing. In the newly developed Illinois Basin, for example, many wells drilled into the McClosky formation—an oolitic limestone of varying porosity—failed to show as much as a drop of oil until the formation had been treated with acid. Acid treatment of wells also is credited with extending the productive limits of

many oil fields in which edge wells incapable of producing commercial quantities of oil have been completed as paying oil wells after acid treatment. Furthermore, many fields in limestone areas that had almost reached their economic producing limit have been rejuvenated and their capacity to produce oil increased by treating them with acid.

"Acid treatment of wells to increase the productivity and ultimate recovery of oil and gas is now generally accepted as standard production practice in Michigan, Kansas, Ohio, Illinois, Kentucky, Oklahoma, Texas, and Louisiana, where oil is found in reservoirs of calcareous and dolomitic rock. In some of these areas acidizing has replaced well shooting; or, where the productive limestone formations are very dense, acid treating is used in combination with shooting to increase the production of oil and gas from wells.

"According to Heithecker,[1] acid treating has caused marked increase in the ultimate oil recovery of some old and nearly depleted fields of Kansas, owing to cleaning-out action of the acid at the face of the limestone, enlargement of the small drainage channels, and probably penetration of the acid into previously undrained porous strata. Estimates of greater ultimate oil recovery of various groups of wells in Kansas show increased oil recovery of 10,500 to 21,700 barrels per well, and the increased recovery per acre is estimated at 1,000 to 2,400 barrels of oil; all this has been accomplished by the additional cost of only a few hundred dollars per well for acid and treating service.

"Although it is known that 1,000 gallons of 15-per cent hydrochloric acid will dissolve about 1,800 pounds or 11 cubic feet of limestone rock, there is no definite rule to govern the quantity of acid to be used for treating an oil well. In some wells a single treatment of 1,000 gallons of acid has been beneficial in increasing the rate of flow of oil into the well and in others, according to Heithecker,[2]

(1) Heithecker, R. E., Effect of Acid Treatment upon the Ultimate Recovery of Oil from Some Limestone Fields of Kansas: Bureau of Mines Rept. of Investigations 3445, 1939, p. 41.

(2) Heithecker, R. E., Work cited in footnote 98, p. 5.

as much as 24,000 gallons of acid (volume equivalent to three large railroad tank cars) have been used during stage or multiple treating, the first charge usually being 4,000, the second 8,000, and the third 12,000 gallons.

"The practice of acidizing wells has grown phenomenally in the past five years, and at present about 10,000 wells are treated annually, requiring approximately 25,000,000 gallons of acid.[3] The rapid development of acid treating in recent years may be ascribed to the development of means for minimizing the corrosive action of the acid on casing in the well, improved technique by contract service agencies, and far-reaching results in increased oil production.

"Acid follows the path of least resistance in a well and sometimes enters depleted or thief zones and stimulates the flow of water into the wells. As it is desirable to confine the action of the acid only to the oil-bearing formation organic gels sometimes are used to control and adapt the treatment to special well conditions. This is accomplished by blanketing or plugging with organic gels the formations that acid is not to contact. The organic material is mixed with a type of bacteria to form a colloidal suspension that is pumped into the well ahead of the acid. Within one-half hour the suspension jells, and the well then is acidized while the troublesome formations are protected by the jelly plug. Within 24 to 48 hours, depending on the temperature in the well, the jellylike substance is consumed by the bacteria and liquefied so that it can be bailed, swabbed, or pumped from the well."

The statements contained in the foregoing summary of my testimony before the House Committee were then true and still are true, to the best of my knowledge and belief.

Mr. Lyon: Now, if Your Honor please, one of these special features that he refers to, this jellifying material and all of that, it doesn't seem to me the testimony given

[3] Kiessling, O. E., Rogers, H. O., and others. Technology, Employment and Output per Man in Petroleum and Natural Gas Production. WPA National Research Project, in cooperation with the U. S. Bureau of Mines, Report No. E-10, July, 1939, p. 150.

by this man before this Committee in Congress is admissible in this case here. We have had no opportunity to cross examine.

Mr. Conner: If Your Honor please, we were placed in the position of calling this witness, which we agreed to do, and which we would still do. Counsel, as of May 3, 1941, entered into this stipulation, signed by Mr. Babcock and myself, that he would so testify if he was called. Now they complain of the lack of ability to cross examine.

The Court: I will let it stand. I recognize if he were here I would be asking him well, how much does that inhibitant do? What would happen if you didn't have it? But he isn't here and I can't do it.

Mr. Wilber Owen: I don't know whether Your Honor noted this statement in the testimony of this man Miller. He said: "The rapid development of acid treatment in recent years may be ascribed to the development of means for minimizing the corrosive action of the acid on casing in wells, improved technique by contract service agents, and far-reaching results in increased output."

The Court: If he were here, I would ask him what he meant by "may be." Whether he means he may have been told that, whether it isn't true, or whether it should be ascribed to that. I don't know. I would ask him, any way, if he were here. I think that is a big thing in the lawsuit, gentlemen.

ERLE P. HALLIBURTON,

a witness called by plaintiff, testified as follows by deposition:

DIRECT EXAMINATION

I reside at 19 Berkeley Square, Los Angeles, California, and am general manager of the Halliburton Oil Well Cementing Company. I have been connected with the defendant company since its organization in 1924 and have been its president all of that period. John C. Halliburton is my brother.

The office of the defendant company has been located at Duncan, Oklahoma, at all times since its organization. I would say that the oil industry was responsible for the organization of the Halliburton Oil Well Cementing Company, and that I promoted the organization of that company. At the time of the organization of the company, I owned a controlling interest in the stock, and have at all times either owned or controlled a majority interest in the stock.

I have taken an active interest in the operations of the company at all times since its organization and have been in as close touch with its operations as one individual could. The company was primarily organized for the purpose of cementing and servicing oil wells. Additionally, we controlled wild wells, furnished a general pumping service with our equipment, worked on wild wells and fishing jobs. By wild wells, I mean wells that got out of control, such as those that blew out. By cementing, I mean the use of cement to seal off formations encountered in the drilling of oil wells, the plugging back of wells, and squeezing the formations of wells with cement.

The Halliburton Oil Well Cementing Company has never owned or drilled any wells, or produced any oil. The company's business is rendering the services I mentioned to others who owned and operated the wells and, as time has passed, we rendered additional services.

I, as an individual, had interests in the oil business prior to the date of the organization of the Halliburton Oil Well Cementing Company. Before the organization of the defendant company I engaged in cementing oil wells, and acted in a consulting capacity as an engineer, and drilled a dry hole or two for myself. Before the organization of the defendant company I had owned some small interests in oil wells.

I was engaged in the cementing of oil wells for seven or eight years prior to the organization of the defendant company, both as an individual, as a partner and as an employee of the Perkins Oil Well Cementing Company. So I was pretty thoroughly familiar with the oil well industry and the oil producing industry prior to the time that the defendant company was organized, and had actually worked in the oil fields in California, Texas, Oklahoma, Arkansas, and Louisiana. Some of these oil fields were lime and some were sand. The wells in Oklahoma were lime. I do not believe that at that time any lime formations had been opened up in Louisiana. There had been lime wells drilled in Texas but not in the fields in which I had worked.

My work in the cementing business brought me in touch with the production end of the oil business to the extent that I had put wells on production, but had never really been connected with the actual production of oil. I had worked around and on wells from the time that they had started until they were put on production; that is, began to produce oil commercially. These were wells on which I did cementing, and I have gone in and killed wells where the water broke into the well that had been on production and cemented these wells, that is, shut the water off and then supervised the drilling of the well to put it back on production.

Subsequent to the organization of the Halliburton Oil Well Cementing Company I organized the Steen Drilling Company that drilled a few oil wells. This company operated in Texas and Louisiana, and I don't remember just what official position I held, but I think that I was presi-

dent. The Steen Drilling Company was organized in 1930 or 1931 and was a Delaware corporation. It was a stock company and I owned control of the stock. This company is not now in existence, as it was discontinued about four or five years ago after operating for some three or four years. E. A. Steen was vice president and Phillip Shumway was secretary-treasurer, and I think I was president of the company. This company drilled a few wells in Louisiana, but their principal operations were in east Texas, and we also drilled wells in south Texas; I think the company drilled one well at Port Lavaca, Texas. The company drilled perhaps forty or fifty wells altogether. I would not know the character of the producing formations in the territory where this company drilled. In east Texas, I know the formation was sand. The company did its own drilling and I don't remember that they contracted with others for the drilling of any wells.

I have been connected with another company engaged in the production of oil, Erle P. Halliburton, Inc., which was incorporated about 1933 or 1934. Erle P. Halliburton, Inc. owns production and took over the Steen Drilling Company's production. This company started in the production of oil maybe a year or two after its incorporation. It did not do any producing of oil prior to the time it took over the Steen Drilling Company. It may have drilled a well or two in Oklahoma in 1933 or 1934. I think that about 1933 we drilled some wells at St. Louis, Oklahoma, and I think that it took over the Steen Drilling Company some time after that. The oil wells at St. Louis, Oklahoma, were limestone wells.

Erle P. Halliburton, Inc., has been engaged in the production of oil continuously since its drilling of the wells in the St. Louis, Oklahoma, district. This business has not been very extensive. I have been president of Erle P. Halliburton, Inc. since it was organized. My wife has been a vice president, R. J. Wilbern has been a vice president, John Halliburton has been assistant secretary-treasurer, and James Coe Halliburton has been a vice president. I

have been active in the control of the operations of the Steen Drilling Company and Erle P. Halliburton, Inc. I have been at the head of the business. Sometimes I am afraid I did not keep in as close touch with the business as I should have, but I did endeavor to keep in close touch with the business. Erle P. Halliburton, Inc. is now producing oil in the East Texas field. I think that is the only place that we now have any production. We contracted the drilling of a few wells in Oklahoma, Kansas and Texas. We do have a little production around Houston, Texas, in what I believe they call the Liberty Field.

By Mr. Owen:

Q. In your early experience as an oil producer, what if any method did you follow in attempting to restore production of a well which had been a paying producer, and which had fallen below a point where it would pay? A. It would depend upon the condition of the well and the nature of the formation being produced, as to what you would do, or what was causing the production to decline.

Q. Prior to 1932, did you of your own knowledge know of any instance where the production of a well in lime formation had been increased by any kind of treatment, after its production had decreased for a time? A. You mean the use of acid in the well?

Q. I mean any kind of a treatment that you know of, of your own knowledge, which was applied to a well to increase its production, in lime formation, from lime formation, prior to 1932? A. You mean chemical treatment or mechanical treatment, or what kind of treatment?

Q. Oh, any kind of treatment that you know of. A. Yes, I have re-drilled wells, lots of them, prior to that time.

Q. Just what would you do in re-drilling them? A. Sometimes drill them deeper to a lower horizon, and sometimes plug them back and drill down and shut the water off.

Q. Were any of those in lime formation? A. Some were, yes.

Q. Do you know of any other treatment that was applied to oil wells producing from lime formation, for the purpose of increasing their production? A. Yes.

Q. What were the other methods you have known of? A. I have known of shooting methods.

Q. Explain that. A. Well, take a lime formation and shoot it with gelatin, nitroglycerine, break the formation.

Q. And was that a common practice prior to 1932? A. Yes, I had seen it done prior to that.

Q. Can you name any other method known to you to have been applied to oil wells for the purpose of increasing their production from lime formation, prior to 1932? A. I had heard of methods, but I had had no personal contact with doing it myself.

Q. You have named all those that you had any knowledge of? A. No, not all that I had any knowledge of. As a matter of fact, I had heard of the use of acid prior to 1932; in fact used acid in a well prior to that time.

Q. When did you first use acid in a well prior to 1932? A. Either in December 1919 or January 1920.

Q. Did you do that yourself, in your own operations? A. I did it under contract for E. H. Royer, in the Hewitt Field in Oklahoma.

Mr. Lyon: If your Honor please, if I remember correctly about that, Mr. Halliburton had no records of that particular transaction, and it was related to getting out drill pipe or tools that had been stuck in the well and using the acid to cut that limestone, or whatever it was, that would stick in the pipe or tools, and as we have so many record cases in our evidence, proof of that with full records, we didn't think it was necessary or there was any use of developing just an oral recollection of that, because we have so many of the same things in our evidence.

The Court: That explains why you didn't ask him about it, and I am satisfied.

Q. Have you named all of the methods known to you to have been used on an oil well for the purpose, or with a view to increasing its production, from lime formation, prior to 1932? A. No, I have known of flooding and vacuum, putting vacuum on the formation. I had also heard of putting heating agents, either chemicals or steam, to

dissolve the paraffin and open up the formation for increasing production.

Q. You have named several. Flooding was one. What do you mean by flooding? A. In which you run water into one well and drive the oil to other wells.

Q. What was another one that you named? A. Putting a vacuum on the sand, with vacuum pumps.

Q. That is on sand formation? A. Well, on lime, or any well where vacuum would work.

Q. And how would you do that? A. Well, seal a well up tight at the top, with tubing in the well, and take the production out through the tubing, and maintain a vacuum in the casing, outside the tubing.

Q. What was one of the others that you named? A. I named the use of heat to dissolve paraffin and clean a well out.

Q. Just how was that done? A. Sometimes chemicals were used, and in some cases run steam into the well.

Q. When you used chemicals it was with the view of having or producing heat from chemical reaction in the well? A. Yes.

Q. Do you say that the use of one or more of these various methods you have mentioned was common among oil producers prior to 1932? A. In some fields, shooting was common, and in some fields different methods. You take wells that paraffined up, it was common practice to remove the paraffin in some manner.

Q. Would it be correct to say that the particular treatment which promised the best results in a particular field was the one used there? A. Well, of course different operators would try different things. Of course some producing zones gave up the oil rather freely and the wells never gave any trouble; and then there would be wells in a field where maybe one out of a dozen gave a lot of trouble, and the other wells didn't give any trouble.

With respect to the oil fields in which I have operated either directly or through my companies, it would be hard to say what the average cost of drilling a well would be.

Up to the present time, I have spent anywhere from $3,000 or $4,000 up to $150,000 on a well. With such an investment in a well, it was a natural thing for any operator to do whatever he could to increase or restore production of oil.

I think about 1933 was the first time the Halliburton Oil Well Cementing Company acidized a well. I don't know exactly who we acidized the first well for, and I don't think there was any record kept on the first wells we acidized. I think the first well we acidized was in Burkburnett in 1933. I am not sure as to that date.

Q. Do you know who owned it? A. I don't remember now who owned it.

Q. And you have no record of that treatment? A. No, I don't have any record.

Mr. Owen: Mr. Babcock, has the company any record of that treatment?

Mr. Babcock: Yes, you have got a copy of it. It is referred to in the Chamberlain-McPherson interference. My recollection it was July, 1933, and it was the King Royalty.

The Witness: Yes, that is right.

Not having been on the job and not knowing the nature of the formation, I wouldn't know about the first oil well producing from a lime formation which the Halliburton Oil Well Cementing Company treated with acid for the purpose of increasing its production. For me to state this would be purely hearsay because I didn't go out on any of these jobs.

By Mr. Owen: Will you refer to such documents or reports as you may have, relating to acidizing treatments of oil wells by the defendant company during the year 1933, or the year 1934, or at any earlier date, and point out the first one in which the defendant company gave an acidizing treatment to an oil well which was producing from lime formation, for the purpose of increasing its production?

Mr. Babcock: I have here some acidizing tickets and invoices which have come out of the file of the Halliburton

Oil Well Cementing Company. I do not know whether these are the first—whether these tickets are on the first well done by the Halliburton Oil Well Cementing Company or not. These (indicating) are all our records that I have been able to find up to, I believe, May 1935.

Mr. Owen: And will you state how many different jobs those represent?

Mr. Babcock: Well these invoices are attached to tickets Nos. 1004, 1005, 1006, 1007, 1008, and 1009, and the earliest date is that of ticket 1004, which is March 2, 1935.

By Mr. Owen:

Q. I hand the documents to the witness and ask him to examine them and state which of them relates to an acidizing treatment of an oil well in a lime formation, for the purpose of increasing its production? A. These documents do not state the kind of acid used, or the nature of the formation that was being acidized, but I assume that all of them were lime formation. One of these apparently was not intended to increase production, but was for freeing stuck drill pipe.

Q. Which number is that? A. It is ticket No. 1006. Tickets Nos. 1004 and 1007 also refer to treatments for the recovery of stuck drill pipes.

Ticket No. 1005 shows that the formation was siliceous lime. Ticket 1008 does not seem to disclose the nature of the formation, but I would assume it was a lime formation that was acidized to increase its production. Ticket No. 1009 reports the treatment of a well which apparently was of a limestone formation. I would assume that the formations of the wells referred to in tickets Nos. 1005, 1008 and 1009 were limestone formations. I have no knowledge of these treatments aside from what appears on the acidizing tickets. I think that Joe Verser would have knowledge of these treatments, as I notice his name appears on all three of the tickets Nos. 1005, 1008 and 1009. He would have knowledge of all three of these treatments and the fact that his name appears on them indicates to me that he was present at the treatments. Ticket No. 1005 is the earliest

and is dated March 11, 1935. Ticket No. 1008 is dated May 25, 1935, and ticket No. 1009 is also dated May 25, 1935. These tickets say they used acid and I would assume that it was hydrochloric acid. None of the wells referred to in tickets Nos. 1005, 1008 and 1009 were owned or operated by me or any of my companies.

I think that the Erle P. Halliburton, Inc., records are located in the Houston, Texas, office and not in this office, and that the Steen Drilling Company records are located here, at Houston, Texas, and at Los Angeles, California. I have no personal knowledge concerning any purchases of hydrochloric acid made by either the Steen Drilling Company or Erle P. Halliburton, Inc., from Dowell, Incorporated. I do not know whether or not the Steen Drilling Company or Erle P. Halliburton, Inc., purchased acid from Dowell, Incorporated.

Prior to the treatments of wells reported in acidizing tickets 1005, 1008 and 1009, I think we pumped hydrochloric acid into wells to free stuck tools and drill pipe, but I don't think we have any records earlier than these tickets where we put hydrochloric acid into limestone formations to increase production, and I don't know of any earlier records.

Mr. Owen: And counsel, I understand, doesn't know of any.

Mr. Babcock: None other than you already have. There is a report on that St. Louis well in that same interference file there which you already have.

Mr. Owen: Can you refer to that one, Earl?

Mr. Conner: Here it is, August 1, 1934.

At this point PX-19, 20 and 21, Halliburton Oil Well Cementing Company acidizing tickets Nos. 1005, 1008 and 1009 and the data attached thereto, were offered and received in evidence.

By Mr. Owen:

Q. I show you a purchase order of Erle P. Halliburton, Inc., No. 1234, a typewritten letter dated June 16, 1934, addressed to Dowell Incorporated, Shreveport, Louisi-

ana, and signed in typewriting "Jack Halliburton" and a letter on Halliburton Oil Well Testing Company stationery dated July 22, 1934, addressed to L. A. Prince, Dowell Incorporated at Midland, Michigan, and signed "Erle P. Halliburton, Inc., by Harry E. Hanson," and ask you to examine them and state if you know what they refer to. A. Well, one of the documents is a purchase order, No. 1234, for 1500 gallons of acid, Barr No. 2; I think that was in Louisiana. The other two documents are letters stating where the charge should be made for the purchase of acid. Apparently Dowell Incorporated acidized the Barr No. 2 well with the acid for the Steen Drilling Company.

I do not know who owned those wells, whether Erle P. Halliburton, Inc., or Steen Drilling Company owned them. I think perhaps Erle P. Halliburton, Inc. owned the wells and the Steen Drilling Company drilled the wells for Erle P. Halliburton, Inc., under a drilling contract and Dowell Incorporated did the acidizing job for Erle P. Halliburton, Inc. Jack Halliburton was not working for Erle P. Halliburton, Inc. I think he was working for the testing department at that time. That was just a partnership, Erle P. Halliburton Company instead of Erle P. Halliburton, Inc.

I think that Dowell Incorporated acidized that well on which the acid was used, but I have no personal knowledge of that fact, as I was not on the job. The basis on which I state that Dowell Incorporated acidized the well is because of the purchase order. The order says a 1500-gallon acid job, and I would assume that Dowell Incorporated did a little more than furnish the acid; they must have furnished some equipment with which to pump the acid into the well.

I have examined a purchase order on the stationery of Erle P. Halliburton, Inc., No. 4618, and it appears to be a purchase order for acidizing a well. The order was issued to Dowell Incorporated at their Shreveport district and was signed by Jack Halliburton, and my testimony regarding this purchase order would be the same as that regarding the other order No. 1234, to which I have referred. This last order, No. 4618, looks like the Burkitt No. 3 well. It

indicates that the acid was purchased from Dowell Incorporated for use in connection with the treatment by Dowell Incorporated of one of our wells. I have examined three documents on the stationery of Dowell Incorporated entitled "Bulk material sales receipt," these being receipts Nos. 2081, 2320, and 4513. No. 2081 indicates that we purchased a thousand gallons of acid from Dowell Incorporated. No. 2320 would indicate that we purchased 100 gallons of acid from Dowell Incorporated and bulk material sales receipt dated December 16, 1934, No. 4513, would show that Erle P. Halliburton, Inc., purchased 200 gallons of acid from Dowell Incorporated. I don't know what the acid indicated in these purchase orders was used for. The orders do not give the well number. I should imagine that the acid was used in acidizing some well some place. In the case of such a small quantity of acid as 100 gallons, the acid may have been used to get cement out of a pump.

Here is an Erle P. Halliburton, Inc. purchase order, No. 4509, Dowell Incorporated's order No. 2320, which would indicate that the acid was used at the Barr No. 2 well, and apparently Dowell Incorporated acidized that well.

Mr. Owen: The purchase order No. 1234 and the two letters attached thereto are offered as PX-23, 24 and 25; the purchase order No. 4618 is offered as PX-26; the receipt for acid, No. 2081 is offered as PX-27; the purchase order No. 4509 and the receipt attached thereto, No. 2320 are offered as PX-28 and 29, and the receipt for customer's order No. 4513 is offered as PX-30.

The Witness: I recognize the signatures on these exhibits and they are those of Jack Halliburton, who was connected with Erle P. Halliburton, Inc. at that time.

I have examined what purports to be an agreement between Steen Drilling, Inc. and Dowell Incorporated, and it is apparently an agreement between Steen Drilling, Inc. and Dowell Incorporated, whereby Dowell Incorporated is to acidize two wells located in Sabine Parish, Louisiana. This agreement was signed by Jack Halliburton on behalf of Steen Drilling, Inc. Jack Halliburton was apparently sign-

ing agreements for the company at that time and I guess he was authorized to do this.

(The agreement was offered and received in evidence as PX-31.)

I have examined what purports to be an agreement between Steen Drilling, Inc. and Dowell Incorporated dated April 20, 1934, and it looks like an agreement to have Dowell Incorporated acidize wells for Steen Drilling, Inc. in Louisiana. The agreement is signed by Jack Halliburton on behalf of Steen Drilling, Inc., and I recognize his signature.

(The agreement was offered and received in evidence as PX-32.)

I have examined another agreement dated April 20, 1934, between Steen Drilling, Inc., or Erle P. Halliburton, Inc., and Dowell, Incorporated, to which is attached a carbon copy of a letter dated July 2, 1934, from Dowell, Incorporated, to Steen Drilling, Inc. This is apparently an agreement to employ Dowell to acidize ten or more wells located in Louisiana, Oklahoma, Kansas, Texas, and New Mexico, within twelve months for Steen Drilling, Inc., or Erle P. Halliburton, Inc.

Mr. Lyon: You mean this is to take the place of PX-32, dated April 20th?

Mr. Owen: That is the fact. PX-32 says ten wells in Sabine Parish, Louisiana, and was with Steen Drilling Company alone. And this other was substituted and made with Steen Drilling or Erle P. Halliburton, Inc., and instead of confining it to Louisiana it includes these other states.

The copy of letter from Dowell, Inc., to Steen Drilling, Inc., was offered and received as PX-33, and the substituted agreement was offered and received as PX-34.

Mr. Lyon: Was the contract ever performed, Mr. Owen?

Mr. Owen: Yes, it was.

The Witness: I have examined what purports to be another agreement between Erle P. Halliburton, Inc., and Dowell, Incorporated, for the treatment of a well. This ap-

parently was an agreement entered into between Erle P. Halliburton, Inc., and Dowell, Incorporated, for acidizing a well in the St. Louis field in Oklahoma, and was signed on behalf of Erle P. Halliburton, Inc., by Paul Halliburton.

At this point carbon copy of a letter from Dowell, Incorporated, to Steen Drilling, Inc., dated July 22, 1934, was offered and received in evidence as PX-35, and the agreement last referred to between Erle P. Halliburton, Inc., and Dowell, Incorporated, dated May 10, 1934, for the acidizing of one well in Pottawatomie County, Oklahoma, was offered and received in evidence as PX-36.

The Witness: Halliburton Oil Well Cementing Company is not denying that Dowell acidized wells for Steen Drilling, Inc., for Erle P. Halliburton, Inc., for Gulf, and for a lot of companies.

The first acidizing of wells, in limestone formations for the purpose of increasing their production that I knew of on what we might call a continued commercial basis was information that I secured from different engineers in Tulsa, Oklahoma, about what the Pure Oil Company was doing. Then, soon after that, I heard The Dow Chemical Company was acidizing wells. After that I believe that Mr. Plummer of the Pure Oil Company called me and wanted to know if I wouldn't go into the business of acidizing wells.

I don't remember that I knew just where the Pure Oil Company wells were located. I knew of the use of hydrochloric acid on lime formation, and I had heard it discussed for several years even prior to that. But in these discussions, it was thought that it would be too expensive for the results obtained. I do not know that the first information that I had of actual acid treatments of oil wells was in connection with wells owned by the Pure Oil Company. The first wells that I heard of being actually treated with acid belonged, I think, to the Gypsy Oil Company. I believe an engineer working for them by the name of Wright was down here on some mud problem, and we discussed it. I talked with him personally about the use of acid. I think he said that through the Mellon Institute, the Gulf and

Gypsy Company or some of their affiliated companies had done some experimenting on acidizing.

I would not know the exact date of the first actual information I received regarding the acidization of wells by The Dow Chemical Company or by Dowell, Incorporated, but I would say that this was perhaps in 1933 or 1934. I certainly would have known about it whenever and if they advertised it. I kept in touch with what was going on in the way of developments in the oil industry and a lot of things that were not developments.

I knew that oil wells owned by companies in which I was interested as controlling stockholder had been and were being acidized by The Dow Chemical Company or by Dowell, Incorporated. I think I knew that we acidized a few wells along in 1934, but I do not know to what extent, and I think I knew that we had employed Dowell to do this work, but I didn't discuss the details of the work with the field organization. On the first job or two I did make an effort to ascertain the details regarding these treatments and the results of the treatments.

Mr. Owen: I have here a number of other papers relating to oil wells which were acidized by Dowell, Incorporated, either for Steen Drilling, Inc., or Erle P. Halliburton, Inc. In order to shorten this portion of the deposition, I will identify these documents, and hand them in their entirety to the witness, and ask him to state what he cares to regarding them.

The Witness: A. The documents would indicate to me that Dowell did acidize the wells, about the dates indicated by the documents.

Mr. Owen: I will ask counsel whether any question will be made regarding the fact that these wells were treated by Dowell for Steen Drilling, Inc., or Erle P. Halliburton, Inc., as indicated in these documents PX-Nos. 37 to 66 which have been identified.

Mr. Lyon: We will waive further proof of these facts, subject to either party having the right to correct the record, if the necessity for any correction appears.

(Thereupon PX-37 through PX-66 were offered and received in evidence.)

Q. Did you know on August 1, 1934, what Dowell inhibited acid was, or did you know anything about it? A. I had known for a long time that hydrochloric acid could be inhibited, and naturally I knew what they were attempting to do.

My first experience with the use of inhibited acid was with the Southwest Shipbuilding Company in 1916 or 1917. We used inhibited acid in cleaning steel castings in San Pedro, California.

I don't remember that I made any effort to ascertain what inhibitor was used in the Dowell acid. I do not know whether or not we had the Dowell acid analyzed in our laboratory.

Mr. Lyon: As I understand it, Mr. Owen, there is no issue in this case that the defendant employed inhibited acid up to some time in January, 1936.

The Witness: I am president of both Erle P. Halliburton, Inc., and Halliburton Oil Well Cementing Company. Some of the holdings of the Halliburton Oil Well Cementing Company are in the name of Erle P. Halliburton, Inc., and I think some of the holdings are in my own name. I would not remember what proportion of the stock of the Halliburton Oil Well Cementing Company is owned by Erle P. Halliburton, Inc., but Erle P. Halliburton, Inc., owns most of the stock in the Halliburton Oil Well Cementing Company. I have at all times owned or controlled a majority of the stock in the Halliburton Oil Well Cementing Company.

I would say that George Hoisington had supervision and charge of the acidizing department when the defendant company first went into that business, and I think that the responsibility of the field operations was gradually shifted onto the shoulders of Charles Clason.

GEORGE T. HOISINGTON,

a witness for plaintiff, testified as follows, by deposition:

DIRECT EXAMINATION

My business address is 1212 Union National Bank Building, Wichita, Kansas, and I am district superintendent for The Halliburton Oil Well Cementing Company. I supervise all of the work this company does in my particular district, that is, cementing, acidizing, well logging, formation testing, dump bailer service, sales, flooding and accessory equipment used in and pertaining to all of the above services.

I have been with The Halliburton Oil Well Cementing Company since April, 1924, and have been working on acidizing since about January, 1935. The Halliburton Oil Well Cementing Company first offered a service of acidizing wells sometime, I would say, in the last half of 1934. As far as I know, this service was first offered commercially, on a revenue producing basis, in my district, that was in January, 1935. It may have been before that, but I do not know whether we had any revenue producing jobs before that or not.

My first acidizing job was run for either the Olson Oil Company or The Empire Oil and Refining Company. I do not recall which. I was treating wells for the oil producing companies, and at that time was in charge of The Halliburton Oil Well Cementing Company's acidizing service in Kansas.

If the period when The Halliburton Oil Well Cementing Company first offered acidizing services on a commercial basis dates from the delivery of the equipment specifically designed to do that work, then I was in charge of that service when it was first offered and that was in my district. At the time this service was first offered, it consisted of offering to deliver the hydrochloric acid and

the equipment to put it in the well. We offered a treater, a helper, the equipment and the amount of acid requested by the customer. On the first two or three jobs, we used just straight fifteen per cent hydrochloric acid, with Mr. McPherson's surface tension reducer, as he referred to it at that time. At that time, I used no inhibited acid. During the time that I was in charge in Kansas I used inhibited acid after, I think, the second or third job which was about January and February 1935. The inhibitors used, as I recall, were Nep 22 and Murodine. I believe I purchased the Murodine from Thompson-Hayward Chemical Company, and the other came on request from Duncan, Oklahoma.

We would use the indicated amount of inhibitor that would be required by the volume of acid that we were running. You have a certain proportion of inhibitor in the amount of acid run. In other words, you use twice as much inhibitor in two thousand gallons of acid as you use in one thousand gallons of acid. I do not recall the indicated amount of inhibitor. The inhibitor was mixed with the acid at the time it was loaded out from the storage station.

We used these inhibitors up until the Circuit Court of Appeals handed down the decision in Denver, in the case of The Dow Chemical Company vs. Williams Brothers Well Treating Corporation, which was about 1936. I used the inhibitors, Nep and Murodine, in my district in Kansas from early in 1935 up to 1936, and those are the only inhibitors I recall using during that period.

By Mr. Conner:

Q. Mr. Hoisington, I show you here PX-19, 20 and 21 which purport to be treatments of wells made by the defendant company, and ask you to examine them and tell me if you have ever seen them before. A. I checked all the signatures of each of these. In the treatment of the wells reported in these reports, fifteen per cent hydrochloric acid was employed. I personally did not have anything to do with the treatment of these wells. I recall doing the initial solicitation and discussion and had most of the conversa-

tions with Mr. Hilligoss. These wells were treated in the state of Kansas, which was my district. It was inhibited acid. The inhibitor was either Nep 22 or Murodine. We used an inhibitor on all treatments, and didn't think anything of it, up until the Circuit Court of Appeals' decision was handed down in Denver. There were one or two jobs run, possibly three, in which no inhibitor was used because we did not have it on hand and the customer did not think it was necessary.

Q. Mr. Hoisington, I again show you PX-19, 20 and 21, and ask you to state whether or not an inhibitor was used in those treatments to your knowledge. A. I rather think that it was.

Q. What is your knowledge of the situation as to whether an inhibitor was used in those wells or not? A. It was our policy to use an inhibitor.

Q. And that was your practice at that time? A. At that time, yes, sir. When we would take a thousand gallons of acid out to a location to treat a well with, we used an inhibitor and our surface tension reducer. That constituted an acid treatment when the job was completed.

Prior to the treatments recorded in PX-19, 20 and 21, the earliest of which treatments is dated March 2, 1935, The Halliburton Oil Well Cementing Company to my knowledge on one or two occasions made treatments with uninhibited hydrochloric acid when we did not have any inhibitor. I am quite sure it (inhibitor) was not used on the first job we run.

JOE KINNARD VERSER,

a witness for plaintiff, testified as follows, by deposition:

DIRECT EXAMINATION

I live in Wichita Falls, Texas, and have been employed by the Halliburton Oil Well Cementing Company since September 4, 1923. I have worked for the Halliburton Oil Well Cementing Company in their acidizing department.

By Mr. Owen:

Q. I show you PX-19, 20 and 21, and will ask you to examine them and state whether or not you had anything to do with the acidization of those wells? A. This Hilligoss well, yes, sir, I treated this well.

The Witness: I also treated this Oko Oil and Gas Company well (referring to PX-21). My name is signed to some of the papers on each of the three exhibits. The Hilligoss well was treated first. It was treated March 11, 1935; we used a thousand gallons of acid of fifteen per cent solution. I did not place any inhibitor in the acid used in this well. I do not think we placed any inhibitor in the acid on either of these other two treatments. At that time we were not using an inhibitor. I am sure we were not. I know we did not on this one (indicating PX-19). I do not know where we bought the acid. It was shipped in a car and I unloaded the car. I do not believe it was Dowell acid.

In this next treatment (indicating PX-20) we used a thousand gallons of fifteen per cent uninhibited acid. We used the same type of acid for quite a while. We were using the penetrant in raw acid. I do not know where the acid came from. It came to us in a tank car. I examined the tank car and it had a rubber lining. I remember that the tank car in which the first shipment of acid was received was also lined with rubber.

In the third treatment (PX-21) we used the same kind of acid, that is fifteen per cent uninhibited hydrochloric

acid with McPherson's penetrant. I believe all the acid for both of these tickets (PX-20 and 21) came in the same car, I am pretty sure, because they were run right along the same time, because we had only one tank.

I recall what inhibitor was used at a later date. The first inhibitor we used was Nep 22, that is a trade name; I do not know what the chemical is or its composition. I do not know where we bought it. Mr. Hoisington attended to that, he bought it through Duncan, Oklahoma, or bought it himself, I do not know. The next inhibitor we used was Murodine, but I do not know where we bought it. I do not know how long we continued to use one or the other of these inhibitors, because I stayed in the acid department only until about June or July of 1935 and then transferred to the cementing department.

CHARLES E. CLASON,

a witness called by plaintiff, testified as follows:

DIRECT EXAMINATION

I have been employed in the Duncan main office of the Halliburton Oil Well Cementing Company since May 20, 1935. My title has at all times been Superintendent of Acidizing. When I entered the employ of the defendant company it was already engaged in the business of acidizing oil wells. I don't know that they had any orders for

acidizing on hand at that time. I think they had a job the day after, although I was not there. It was up in Kansas, and I was in Duncan. They had in stock acidizing materials at that time. They had muriatic acid or hydrochloric, in a storage tank, and that so-called reducer, and I believe they had some of that Nep compound inhibitor. I don't remember, but it seems to me they had some there in their pump house, at Hutchinson, Kansas. After I went with them they used that as an inhibitor for a time, and then Murodine. They used Nep possibly two months after I went with them and then they switched to Murodine. From hearsay, they used Nep as an inhibitor before I entered their employ. They stated that they had some on hand there. It was carried in stock at that time. I think I saw a drum there that had some in. Probably 50 or 52 gallons, whatever the standard is. It was a liquid. We continued to use what they had on hand, and did not buy any more. We then started using Murodine because it was easier to obtain, as we got it right in Wichita, Kansas, from Thomas and Hayward.

Before I went to work for the defendant, I worked for the Dow Chemical Company twenty years in Midland, and then I think it was about the time I went to Kansas that they organized the subsidiary unit of Dowell, Incorporated. That was in November, 1932. Regarding my duties with the Dow Company immediately prior to the organization of Dowell Incorporated, I was in the acidizing work here in Midland County. I was one of the first to get into that work with the Dow Company. I witnessed some of the early treatments of wells using the Grebe-Sanford acidizing method in Michigan, before I went to Kansas.

When I went to Kansas, I was in charge of Dowell's treating station, and continued in charge of that station for about two and one-half years, roughly. I left the employ of the Dowell Company about May 12th or 14th, along in there some time, 1935, and entered the employ of the defendant on May 20, 1935.

I am familiar with the construction of the steel tanks

used by defendant for transporting acid to the wells to be acidized. The sketch which was made by Mr. J. J. Edwards during the taking of depositions in June, 1939, in this case, looks about the way they would if you looked down inside the top. In the upper figure marked Figure 1 the eight squares marked with an X, are lead plates and they are brazed or soldered to the bottom of the tank. I believe the custom is before those plates, which I think are about 30" square, are put into the tank, they weld a strip of steel or take a strip of steel and braze the edges of these plates to that strip of steel. Now, that is rather a fussy job, attaching that lead to the iron, lead burning, there are a lot of fumes concerned. That can be done in the open. Then when they come to here (indicating) it is a simple matter to spot weld the steel to the steel. The lead plates are put in at the Halliburton shops. We buy steel tanks and then equip them with these lead plates. This line marked A-A' shows the dividing line between the two compartments of the tank, which are not connected so that the acid can go from one to the other. One can be filled and the other empty. These other cross lines between the lead plates probably represent baffle plates. From the bottom they come up eighteen inches, I should say. Possibly a little more. They are to prevent undue slopping of the acid in transportation.

I know something about the electrical treatments that are given to these tanks before they are put into service. We found that when a new tank was put into operation there is a certain amount of current flow until the tank becomes polarized. Now, this current flow results in a deposition, I think, possibly, of lead. At least, it looks like it. I have never analyzed it. But, at least, there is some action there and the tank becomes polarized. Now, that is at the expense of the plates in the tank, and the action comes at the point of contact of the lead and steel. Well, now, naturally, a bare new tank, there is going to be a lot of action there at the start when the acid is put in, when polarization takes place. Now, to alleviate the using

up, you might say, of those lead plates to the extent of where it loosens them, we hung some lead strips in the acid and connected a battery with it to actually deposit this, and thereby not have a job in a very short time of replacing those lead plates. We found that then they would last for a great length of time.

Mr. Lyon: What did you do with the acid that you employed in that polarizing operation? A. That was usually—it may be used, and it might—may have done two things. They have used that acid when it was strong acid, but they have had instructions that it isn't necessary. You could use a weak solution, two or three per cent, and throw it away.

By Mr. Owen:

Q. You mean they have used that acid, used in the polarizing operation, for treating wells? A. That particular tank load could have gone in a well.

In the polarizing operation, we drop down in the manhole of the tank a lead plate which we connect up to the plus side of a battery. The direction of the current flow is from the lead into the acid to the steel and back to the other pole of the battery. The other pole of the battery we connect to the steel tank, as illustrated in figure 2 of this sheet, Mr. Edwards' sketch. I have seen them use for this purpose an ordinary 80 ampere battery such as used to go in Fords. They would let it run down completely. You could see it taking some lead off the lead strip, and that lead goes onto the sides of the steel tank inside. We do that preliminary treatment to prevent too much attack on the lead strips, which were previously placed in the tank. That action comes on the point of contact there.

Mr. Owen: I will offer a photostat of this pencil sketch which was made by Mr. Edwards as PX-71.

(The sketch referred to was thereupon marked PX-71.)

The Halliburton Company stopped acidizing wells shortly after the decision of the Circuit Court of Appeals in the Williams case. That was perhaps in January of 1936. At that time I knew of the Chemical Process Company.

They were in the business previous to that time. I did not know what kind of acid they were using. Previous to that time, January, 1936, I think pretty near everyone used inhibited acid.

Mr. Lyon: Are you testifying you had any knowledge? A. No, that is just an opinion. I don't know.

PX-186, which is entitled Howco Method of Protecting Tubing and Casing against corrosion while acidizing a well, and which bears the date March, 1937, on the title page, was published quite a little time after defendant started acidizing again. I think this was the first published announcement, but I think they had actually started in business before this was published. I think it was in June, 1936, they started using that Menaul method.

During that period from January to June the Halliburton Oil Well Cementing Company was out of this acidizing business entirely, for this purpose.

CARL A. NICHOLAS,

a witness called by plaintiff testified as follows, by deposition:

DIRECT EXAMINATION

I am 31 years old and employed by the Halliburton Oil Well Cementing Company as a treater. I supervise acid treatments of wells made by that company, and, at present, am located in the Salem oil field in Illinois where I have

been since about the first day of May, 1939. I have been employed by Halliburton since December of 1936.

From April 20, 1938, until February, 1939, I was stationed at Mt. Pleasant, Michigan and worked for the Halliburton Oil Well Cementing Company in the capacity of a treating engineer in charge of acidizing oil wells. My job was that of supervising the acid treatments given to oil wells by Halliburton, and I checked the field and also solicited business. The Halliburton Oil Well Cementing Company, at Mt. Pleasant, Isabella County, Michigan, maintains an office with a telephone listing and a treating station from whence they acidize oil wells.

At the time I was located at Mt. Pleasant, Halliburton had two combination units, which handled both acid and cementing, and equipment for transporting acid to the wells. At Mt. Pleasant, Michigan, Halliburton also had two acid storage tanks which were located just back of the Sun Oil Company's bulk plant, right across from the Isabella County Railway yards on the north side of town. These storage tanks were made of wood and had a capacity of 250 barrels each.

As to the various services and materials which Halliburton offers to the petroleum industry in connection with acidizing oil wells, I am familiar only with those services and materials that I used. I am familiar with the type of acid used by Halliburton and know that hydrochloric acid of 15 per cent is used when acidizing oil wells. I obtained all of my experience as an acid treating engineer after having come to work for the Halliburton Oil Well Cementing Company.

I am considered to be an experienced treater and am sent out to a well and given full charge of treating that well. As a rule, I do not have any assistance in treating a well other than truck drivers who drive the trucks to the well location and do the necessary work of hooking up various pipes and pumping the acid into the well. I supervise the job.

When I was located at the Mt. Pleasant Station of the

Halliburton Oil Well Cementing Company, I had occasion to treat wells in Ogemaw, Arenac and Gladwin Counties, Michigan. When treating wells in these counties the acid employed would come from Halliburton's station at Mt. Pleasant, Michigan. To my knowledge, I never treated any wells in these counties wherein the acid did not come from Halliburton's storage at Mt. Pleasant, Michigan. In treating an oil well, as a rule, I would be present when the transport tanks were loaded with acid from the storage tanks. In treating a well the first thing we would do would be to get our truck drivers together and then load the acid transport tanks with acid. Water was always first loaded into the acid transport tank, and then 20 per cent Baume acid was added to this tank from the storage tanks at Mt. Pleasant.

Then, of course, we had to make the trip to the well location and after that, the first step in treating the well would be to load the well hole with oil. Then, you would proceed with your acid treatment by putting your acid into the well. The usual procedure is to bleed off oil until you have your formation covered with acid and then you close in the well and force the acid into the formation. The tubing and open well hole is flushed with oil so that all of the acid is forced into the formation. Pressure is used in order to force the acid back into the formation. When we arrive at a well to treat it, we would have a truck with a pump mounted on it, and the truck would be pulling a trailer containing an acid transport tank.

The truck driver or drivers and myself make all necessary pipe connections to place the blanket, acid and oil in the well hole. Employees of Halliburton make these connections, and operate the pump to put the blanket, oil and acid into the well. All operations relative to treating a well with acid are done by Halliburton employees, and when anyone other than myself does any work in connection with treating a well, that work is done under my instructions and supervision.

Part of the hydrochloric acid used by the Halliburton

Oil Well Cementing Company in treating oil wells in Michigan came from the Pennsylvania Salt Manufacturing Company at Wyandotte, Michigan, and the rest of the acid came from the General Chemical Company at Norwich, a suburb of Chicago, Illinois. The acid was shipped to us in rubber-lined tank cars. Part of the time I unloaded the acid from the tank cars and put it into the Halliburton storage tanks and part of the time some of the other employees of the company performed this operation. I checked the unloading of this acid, and when a tank car of acid was received I was responsible to Mr. Edwards for its unloading. As a rule, when a tank car of acid was received at Mt. Pleasant it was unloaded that same day, and put into the storage tanks. That was our usual practice. When we used this acid to treat wells, it was diluted with water.

The formations from which the oil wells in Michigan produce oil are limestone and dolomite. I know the action that hydrochloric acid will have on calcium carbonate and on typical limestone formation. The action is such that the acid will consume a certain percentage of the calcium carbonate, and that is the reason we used hydrochloric acid in treating these limestone formations in Michigan. By pumping the acid into the formation under pressure you merely open channels in the limestone which are formed by the acid spending itself on the formation. Whether or not it is necessary to allow the acid to remain in the formation any length of time depends entirely upon the formation. Some formations are fast reacting when subject to the acid and some react slowly. The length of time that the acid is allowed to remain in the formation sometimes varies from an hour to several hours.

When I received the acid from the manufacturer, I made no tests or analyses of it. When I took it out of the storage tank prior to putting it into the transport, no tests or analyses of the acid were made at that time, nor were any tests or analyses made at the time it was put into the transport tank and before it was put into the well. When the acid was taken out of the storage tank and prior to

putting it into the acid transport tank or after it was put into the transport tank but before putting it into the well, I usually tested the acid with a hydrometer to check it to see if it was 15 per cent strength treating acid. The only tests I made at any time between the time I received it from the manufacturers and the time it was used in acid treating a well was merely a test made with a hydrometer to determine the strength of the acid. With respect to the materials employed in treating wells in the counties of Ogemaw, Gladwin and Arenac, Michigan, no tests were made of these materials just prior to putting them into the well. I did not save any samples of these materials. There were some instances where the operator saved samples of the acid. What he did with them I do not know. I made no tests or analyses of the acid while it was being retained in the storage tank at Mt. Pleasant, Michigan. To my knowledge, no samples of that storage acid were retained and I never retained any specimens of that acid and saved them. It has never been my practice to make such tests and to take such samples while the acid was being retained in the storage tanks at Mt. Pleasant, Michigan, and I never saw or heard of anyone doing it.

I am familiar with and know the construction of the equipment employed by the Halliburton Oil Well Cementing Company in acidizing wells. The acid transport tank is a steel tank and is built on a trailer. Those used in Michigan are constructed with two compartments of 500 gallons each and have baffle plates crosswise and lengthwise in each compartment. These tanks have lead plates bonded in them, and there is a dome in the tank for filling it. The tank has a suction manifold with two connections, one leading to each of the two interior compartments. I believe there are four lead plates bonded to the bottom of each interior compartment of these transport tanks. I do not know the exact size of these plates. I believe they are about 30 inches square, and that there are eight in all in each transport tank. These plates are about one-eighth inch in thickness.

When treating an oil well with acid, aside from the pipe connections that extend from the pump or acid tank to the well tubing, there is another connection which comprises a heavy electrical bronze cable, one end of which is connected to the acid transport tank and the other end to the well tubing or casing.

I have acid treated better than 100 wells in Michigan and they were all treated by me while working for the Halliburton Oil Well Cementing Company. When we first went in the acidizing business at Mt. Pleasant, Michigan, the original acid transport tanks were there before I arrived. Some Ford transports arrived at Mt. Pleasant after I was there and they had tanks on them for transporting acid.

Before utilizing these tanks for transporting acid, they were electrically polarized and there was one or two of these tanks that came to Mt. Pleasant, Michigan, that had not been electrically polarized. These tanks were polarized by using 15 per cent acid and extending lead strips down into the acid. These lead strips I refer to are additional to the eight lead strips which are bonded to the bottom of the tank compartments. The additional lead strips are put on a wooden frame that sets across the dome of the tank, and they are connected to the tank through a storage battery which is then allowed to lose its charge in that process. Now, as to what happens there, I would not be able to tell you. I merely followed instructions as to what was to be done. I helped position these additional lead strips in the tank. Only a portion of these additional lead strips was immersed in the acid, but they were not in contact with the walls or top side of the tank, but in contact with them only through the battery. By means of wires, I helped to make the connections connecting the battery up with these additional lead strips on the inside of the tank. I saw this done. We used an ordinary six-volt storage battery.

When I would treat or supervise the treatment of wells in the counties of Ogemaw, Arenac or Gladwin, Michigan, I would make a record and report of that treatment to the Halliburton office in Mt. Pleasant, which consisted of a

data sheet, in the form of a work order. This was always made out before the acidizing job was done and was signed by the operator or the well owner's representative. We kept an acidizing ticket as a record of the well treatment. The acidizing ticket showed the time involved in making the treatment and the pressures required or actually used in forcing the acid into the formation. The acid ticket further would show that the well was treated by the Halliburton Oil Well Cementing Company, would give the date of the treatment, the address of the party or well owner for whom the treatment was made, the position or location of the well as to the lease, well name, section, township, range, state, county and pool, where such information was available. The acidizing ticket also gave the time that our equipment arrived at the well, together with the numbers of the equipment to identify it, the distance of the well from the station making the treatment, the amount of oil used in treating the well, the number of pumps used in placing the acid, oil and blanket or other material used into the well, and also indicated on this ticket was the time when the acid was placed in the bottom of the well.

The table entitled "Pressure Record" appearing on the acidizing ticket is for the insertion of figures in the time column to show the length of the treatment. This column will indicate any changes made in the treatment with respect to the volume of fluid and the pressure required to force it into the well. Any time there is a change in the pressure or change in the directions of treatment in any way, that is recorded on this record. Under the headings "Time," "Vol. acid in," "Casing" and "Tubing" (the last two headings under "Pressure") at any given time show the amount of acid in the well at that time. The next column to the right shows the pressure on the casing and on the tubing, together with the amount of acid in the well. The acidizing ticket further shows the amount of oil used to flush the well and the pressure on the casing and on the tubing at the end of the treatment; and the ticket further shows the materials used and the charges made therefor by the Halliburton Oil Well Cementing Company.

At the bottom of the acidizing ticket appears the word "treater," at which place the Halliburton treating engineer would, as a rule, in his handwriting, insert the name or names of the Halliburton men helping him. Over the line marked "Owner of well or agents" the well owner or his agent signs his name. The acidizing ticket is further filled out to designate which of the Halliburton treating stations is rendering this acid service. The well owner or his agent is given a copy of this acidizing ticket. It was my practice while employed by the Halliburton Oil Well Cementing Company at Mt. Pleasant, Michigan, and when making acid treatments to fill out such a record as I have been discussing, which record is entitled "Acidizing Ticket."

I have examined the acidizing ticket No. 6581 of the Halliburton Oil Well Cementing Company, and this ticket is a report on a well which I treated. The well was treated for the Chapman Oil Company, April 27, 1938, using a thousand gallons of penetrating acid and 4 gallons of blanket. The well treated was the State Well No. 2 located in Midland County, Michigan. I was the treating engineer in charge of acidizing this well, and this well was treated for profit. I have also examined acidizing ticket No. 6583 of the Halliburton Oil Well Cementing Company, and this record indicates that bean powder and blanket were used in treating the well listed in this report. I have also examined the acidizing tickets Nos. 8184, 8185, 8188 and 8196 of the Halliburton Oil Well Cementing Company.

Mr. Owen: Your Honor, these last tickets are the treatments that are involved concerning which infringement is charged.

Mr. Lyon: I didn't quite understand the statement of Mr. Owen. What is there in particular about these four tickets?

Mr. Owen: These are the tickets which relate to the treatments from which the samples were taken upon which the charges of infringement are based.

Mr. Lyon: We are going to object to any evidence in regard to those treatments, the samples, if they are relied

upon to establish infringement because their position is—I don't think it is contested—that those wells were acidized and the treatment performed with the consent of the plaintiff. Of course at the plaintiff's instigation, and the plaintiff cannot sue, and Halliburton is not liable as an infringer for carrying out Weber's request, or what Weber had been authorized to do by the Dow Company. We object to the evidence of those wells. I don't think you deny that the Dow Company authorized the Weber Company to hire Halliburton. We object to that. I don't think you deny that the Dow Company authorized the Weber Company to hire Halliburton to perform those treatments.

Mr. Owen: I am perfectly willing to state to the court just what took place. Plaintiff had for some time endeavored to secure evidence of just what the defendant was doing, just what it was using. The manner and nature of this business is such that they had no means of ascertaining when the Halliburton Company was to make a treatment. They couldn't get that information from the Halliburton Company. They had no means of knowing when or where Halliburton was to make a treatment, and therefore, in order to secure samples of the materials that were being used by Halliburton, the representative of The Dow Chemical Company, or of Dowell, I don't know which, arranged with the Weber Oil Company to secure a certain number of treatments from the Halliburton Oil Well Cementing Company and to take samples of the materials used which were to be delivered to plaintiff, and that was done.

The Court. Who paid for the job?

Mr. Owen: So far as the transaction between Halliburton and the Weber Oil Company was concerned, the Weber Oil Company paid for it, although the Dow Company reimbursed the Weber Oil Company but Halliburton didn't know that.

Mr. Lyon: How do you consider that an infringement?

The Court: The plaintiff gets something that is infringed in the trade, and goes around and buys things, I suppose, to catch the claimed infringing defendant, and I

have never had that question raised before. I suppose they could say in all those cases, a bolt or nut claimed to be infringement made by the defendant, and they get some retail fellow out in the country somewhere to order it.

Mr. Conner: If Your Honor please, at this time it seems that defendant finds itself in this position, that here they are in Mt. Pleasant, they have a place of business, they are acidizing wells, they are accepting such business, they are trying to get this business. Now, merely because they treat wells for these particular people, they maintain under that circumstance,—and we get evidence of what they are doing, that that is not infringement; but, you must not fail to see that they are taking all the acidizing business they can get, and doing the same thing on each and every well.

This thing of treating a well is a very hard thing, usually. I don't know how much business they get, but in order to get evidence of the infringement,—it is not a material thing, it is not solid, it is a method claim, and in order to get evidence whether they are infringing or not we have to be right there and watch every single step they take, and how they do it, and what they do it with.

We arrange for these treatments. We ask Weber, will you get some treatments from Halliburton. Does Halliburton have to take those treatments or not? All they do is accept that business in their normal course of their everyday operations.

The Court: I was trying to say, but I was interrupted, it is just the usual thing that I get in all cases. This is the first time I have ever had this question raised as to whether most of them prove the infringement. If there is any difficulty at all they get some people that are engaged in business out around that are friendly to the plaintiff, the patent owner, to order some of these things. I don't suppose when we come to an accounting, perhaps, that they include that at all. I don't know. But, they do the same thing in criminal cases.

Mr. Conner: I want to get in here there is no such

thing here as entrapment. There is no question of entrapment.

The Court: They don't claim entrapment. We are right in this building. We will say this building and every other post-office building is built with peek-holes so that they can watch the clerks, and the clerks all know it, but in spite of that once in a while they are so tempted by a letter they see money in, they take it. They haven't the right to send those things through the mail, put temptation in their way; they haven't a right to go and coax somebody that isn't violating the law to become a violator. Then you get over into the inducement, and I never liked the word, because I always understood you always had the right of setting a trap, and they do it in criminal law. They set a trap. And, they fall through it if they are regularly in the business. They do it with bootleggers. You could go to a man who is making moonshine and coax him to go and make you some, and offer him good money, and he goes. The officers of the law do that. That is putting temptation in the way of an honest man.

But if he already is doing the thing, and you just try to get proof of what he is regularly doing, then I understand you have a right to do it. You didn't do this different because they did not specifically ask you, as I understand it, to put certain things into it and do it in a particular way.

Mr. Lyon: Well, they asked us to put the blanket in.

The Court: What?

Mr. Lyon: They asked that the blanket be put in for one thing. I haven't finished my explanation of my point, if you please, if I could.

In the first place, there is a principle that jurisdiction in the Federal Court cannot be established by collusion, and in this case the Halliburton Company is not an inhabitant of the State of Michigan or of this District. In order to establish venue in this case, the defendant, as I understand it, relies upon these particular four wells—or the plaintiff does. And, to prove infringement, Halliburton Company

not being an inhabitant of this district, it can only be sued if it has a principal place of business here, which it has, and has infringed here.

The Court: Yes.

Mr. Lyon: Now, then, to prove that infringement, which is denied in the answer, the plaintiff relies on the collusive transaction here between this Weber Oil Company and the other oil company, the Petroleum Investors, Incorporated. And they say, "Here, Halliburton, you have infringed because you have treated these wells for these companies."

Now, that couldn't have been an infringement unless the Petroleum Investors Company and the Weber Company were infringers. The work orders which are here in evidence under which this work was done provide as follows, typed on each one:

"Also it is necessary in work of this nature to depend largely on indicated conditions in a well and there being natural uncertainty as to measurements and variations of formations to be treated it is expressly agreed—" these were signed by these oil companies and Halliburton— "—first, that Halliburton Oil Well Cementing Company makes no guarantee of the effectiveness of the materials to be used in the treatment of the well nor of the results of the treatment.

"B. That it shall not be liable for any injury or damage to the well growing out of or resulting from the treatment of said well or from the use of said equipment in doing said work.

"C. Halliburton Oil Well Cementing Company only agrees to furnish the materials here on order and any equipment suitable for placing said materials in said well and two operatives to assist in performing the work under the supervision of the owner of the well or his representative."

So, unless the owner of the well, the man for whom the work was done, was an infringer, Halliburton can't be a contributory infringer or joint infringer. You can't be a

contributory infringer unless you contributed something to such infringement, or you can't be a joint infringer unless there was another joint infringer, and in this case these oil well companies were authorized by the Dow Company to do this very job. They had their permission.

This isn't a question of entrapment. We are coming down to the question of whether or not this is a legal venue of these four cases, if they can be used to establish venue here, because they were by collusion. And if Your Honor hasn't read it I would suggest you consider the decision of Judge Westenhaver in Southern Textile Machinery Company vs. Wovenright Knitting Company, 44 Federal Second 234, a decision he wrote in 1925 under this venue statute in patent cases, dismissing the case because there was collusion in establishing the venue. The plaintiff went in there and colluded with the person to establish the sale in that district.

The Court: How about this line of reasoning, though: The proof already shows that they probably have treated 100 wells in this jurisdiction here. Now, then, they analyze only four wells, and your objection, if you are limiting it to that question of collusion—but how about taking that as very good circumstantial evidence of the fact that all of those wells that you have been treating here were of that kind?

Mr. Lyon: Well, my objection is based on this, Your Honor, because I asked Mr. Owen what he relied on those four wells for, and he said those were the four he was relying on to establish infringement.

The Court: But I realize that he relies on those four, and then I don't know whether he does or not, but I would assume that circumstantial evidence as to the others—in other words, suppose I found against you all the way through and you finally got around to the accounting, the court wouldn't stop with an accounting as to only those wells they analyzed, but they would use that as circumstantial evidence of what was done in the other cases, I think.

Why not use that in the same way as to this? I don't

see as they are limited to the four wells they have analyzed. That is all they have analyzed and from that they draw certain conclusions. You take—oh, I don't know whether I can think of a good example or not, but we have it all the while. We go into- -well, take the ordinary bootlegging case, you go in and they see them selling drinks right along, they watch them for a while, and they are selling drinks. They go in and they buy only one drink, but you reach the conclusion that they are bootlegging to the others because of what the one got. He will ask for the same thing, the same thing he hears them ask for.

Mr. Lyon: I see Your Honor's point all right, but I don't see what it is going to lead us to, because the proofs so far as they have disclosed in the preliminary depositions in this case, I can't tell whether they charge that on these four wells something was added to these acids, some minerals were put in the acid or some inhibitor put in. They present certain analyses of the acid before and after. Now, we asked them if they wanted to stipulate if what was done on those four wells was typical and representative of what was done on the other wells they were treating in Michigan, and they refused to stipulate.

Mr. Owen: No, we didn't have any such proposition, and I am perfectly willing to stipulate to that.

The Court: They certainly can't get any stronger conclusion unless they prove something.

Mr. Lyon: If they are going to contend that on those four wells somebody put something in the acid, which we say we did not do, and those jobs were done at their request, the evidence shows, for instance, that in connection with the well for the Petroleum Investors, one of the four they rely on, that as a matter of fact the Dow Company had a man there in the field who told them what they wanted done, and directed the treatment of the well as to the putting in of the blanket, and so forth, and the Halliburton people thought he was a representative of the Petroleum Investors, but he was a Dow man.

If they are going to rely on any finding of iron or

copper or anything else in these acids, we are not willing to stipulate, and I don't think the court should infer from that that there would be such things in the other wells, as they say that that proves that somebody put something, some copper or some lead or something into the acid.

If they are willing to take our statement that no such thing was done, why then, of course, we are not so much concerned about this point, but what we are concerned about at this point is that if they are going to argue that something peculiar, something beyond what we admit we did here in these four wells occurred, they are going to rely on these four wells and their analyses on these four wells to establish their infringement, we want to reserve the point that those four wells are not infringing wells.

The Court: Well, I will overrule the objection, and you have got your exception to it, and whether I have got circumstantial evidence that leads to some certain conclusion or not, I will have to wait until I have heard all of the evidence and all of the circumstances and every other kind of evidence. But I think that fully protects your record and I will let them go ahead. I will overrule the objection.

Mr. Owen: I would like to state this for the record, Your Honor, that the plaintiff is relying upon what we found in the acids from these wells, and what the defendant did in treating those wells, as representative of the treatments that they were giving throughout this district, and that if the acids of which we took samples, and those particular treatments, are infringements, we will contend that all of the other treatments made during the same period, by the defendant company, in this district, were also infringements.

The Court: I will hear the proofs. They probably will be telling me about what was done there, and how it was done, and what was done in other places, before they are through. Anyway, I will hear the testimony.

You may go ahead.

The Witness: I have examined the acidizing tickets

Nos. 6581, 6583, 6585, 6587, 6589, 6592, 6594, 8161, 8167, 8176, 8184, 8185, 8188, 8196 of the Halliburton Oil Well Cementing Company, and these tickets are reports on wells which I acidized or which were acidized under my direction, as a representative of the Halliburton Oil Well Cementing Company. I was the treater in charge of acid treating all of these wells referred to in the above tickets. These wells were treated in the State of Michigan from the Halliburton Oil Well Cementing Company's Mt. Pleasant station. The wells which were treated and reported in the acidizing tickets Nos. 8184, 8185, 8188, and 8196 were treated by the Halliburton for the Weber Oil Company. These wells were located in Ogemaw County, Michigan. There is data on these tickets which indicates whether or not we employed pressure in connection with placing the acid in the well. The pressure indicated on these tickets shows the pressure it took to pump the acid into the formation. I put the acid back into the formation, or rather, I endeavored to put it back into the formation. So far as I know, the data on these tickets truly represents all of the facts relative to the actual treatment of the well. These tickets also give the location of the well and the materials employed in treating it. The acid was forced into the well by the application of pressure and the well was closed in so that the acid could not come out of the well. I do not remember exactly how long the acid was allowed to remain in the well, but it stayed there a few hours possibly. The acidizing tickets do not indicate how long the acid stayed in the well.

Acidizing ticket No. 8188 shows that a two-stage acid treatment was given to this well and that after the first stage was finished the acid was allowed to stay in the well for a short time. I would not attempt to say how long the acid stayed in the well, and the acidizing ticket does not indicate this. As indicated on the acid ticket No. 8188 between the time of 11:38 a. m. and 2:30 p. m. the acid was allowed to stand in the well a while, and then the well was swabbed and cleaned up. The second stage of the treat-

ment then proceeded, commencing at 2:30. After the second stage of the treatment, the acid was allowed to stand in the well for a while, but how long I could not say. This was done under the supervision of the superintendent of the Weber Oil Company and he took care of that himself. He told them how long to leave it set and how long to swab it. This acidizing ticket No. 8188 reports on a three-stage treatment.

I have examined aciding ticket No. 8184 of the Halliburton Oil Well Cementing Company and, to my knowledge, this ticket is a report on the first well acidized by Halliburton for the Weber Oil Company. At the bottom of the ticket appears the name W. L. Steelman, whom I contacted with respect to this well, but I do not know exactly when. He was in charge of this Stella Wilcox well. I treated the Stella Wilcox well as indicated on these acidizing tickets on two different occasions, namely, on August 2 and on August 5 of 1938. I can not tell by reference to these tickets whether or not this well had been acidized before. I would have been told by the well operator, as part of my knowledge preparatory to treating the well, if the well had been previously treated. I cannot say whether that well was acidized by anyone else prior to August 2, 1938, when I acidized it for the first time.

When treating the Weber Oil Company's Wilcox well on August 5, I used 2000 gallons of acid and 25 barrels of oil to flush the acid and with which to push the acid back into the formation. When I finished treating this well, the acid was allowed to remain in the well for a short time. I do not know how long. To get the acid out of the well, the well was swabbed by the Weber Oil Company.

By Mr. Conner:

Q. At your completion of acidizing that well on August 5, could the satisfactory acidization of that well be effected without swabbing or withdrawal of that acid? A. What I can't understand is what you mean by that. It has got to come out.

Q. The acid must come out of the well in order to

satisfactorily acidize that well, is that correct? A. Here is the thing, the well has to be produced. And in order to produce it, you are going to have to remove the fluid. When they go in there to produce a well, as far as whether the treatment is successful or not, the time that is left before it is put on production is probably immaterial as to the results of the treatment.

Q. You stated as far as you knew this well had never been acidized before? A. I could not say. I don't remember and I could not tell by looking at this ticket here.

Q. Then, as acidizing treating engineer, when you finished the acidization of that well, as reflected by that ticket, for the Stella Wilcox on August 5, what if any instructions did you give Mr. Steelman, as the operator, relative to putting that well back on production, with respect to the withdrawal of any spent acid or fluids in the well before the well could be produced again and production from that well put into the production lines or tanks? A. Well, to my knowledge I gave him no instructions, because I worked under his instructions on those jobs, and in this particular case there, Mr. Steelman told me what he wanted done, instead of me making any suggestions. However, had it been against the ethics of treating or anything, I probably would have made some suggestions, but in this particular case I gave him none that I know of.

Q. You testified that you have treated some 200 or more wells, is that correct, with acid? A. Yes, sir.

Q. Now, is it now necessary, after putting the acid into the well and forcing it back into the formation with oil, and after the well had been shut in for a period, to then remove the spent acid or fluids from the bottom of the well before the well is put back on production? A. In most cases, yes, sir.

Q. All right. When you were treating a well for an operator, who had never had a well treated before, did you not instruct the operator as to what should be done in order to put that well back on production? A. I merely gave him suggestions of what other operators have done. After

all, either the operator or some representative of his usually has some knowledge of the acid business.

Q. Then, removal of the spent acid is a necessary step to the acidization of a well, is it not? A. Surely.

Q. This spent acid must be removed, is that correct? A. In lots of cases you don't get your spent acid back.

Q. But if it is there and can be gotten back, it must be removed before the well is producing again, is that correct? A. Some wells are put right on production without removing this spent acid.

So far as I know, the acidizing tickets that I have referred to are the most complete records relating to the treatments of the wells reported in these tickets, I made all of the entries recorded in these tickets and, to my knowledge, they are true. I did not retain any specimens or samples of the materials employed in treating the wells recorded in the acid tickets Nos. 8184, 8185, 8188 and 8196. I do not know whether anyone else in my organization retained any specimens or samples of the materials used in treating these wells. I made no tests or analyses of any of the materials employed in treating the wells identified by these four tickets, and I do not know whether anyone else in my organization made any tests or analyses of these materials. I did not make any tests or analyses, and so far as I know, none of the other employees of Halliburton made any tests and analyses of the particular materials used in treating these four wells.

Neither I nor anyone else in my organization, to my knowledge, made any tests or analyses of the materials used in treating the wells referred to in the other acidizing tickets, and neither I nor anyone else in my organization, to my knowledge, retained any samples or specimens of the materials employed in treating any of these other wells.

Q. Did I not understand you to state that after you and your crew had finished operations of putting the acid in the well, that you, in some instances and on some occasions, made suggestions to the operator relative to what should then be done with the well in order to put it back

on production? A. There are some cases when the operator and his employees are not familiar, and I merely suggest policies followed by other companies and their employees.

Q. What are those suggestions you made on those cases? A. That would depend entirely upon the situation to be covered.

Q. What suggestions of any type have you made to the operators under those conditions? A. Well, that would be awfully hard to say. I could not go back and recall them.

Q. Can't you give an example of such a situation? Did you not tell him what should then be done with the well in the event he did not know of it, in the instance we are now speaking of? A. No, sir, I would not want him to use my word as authentic.

Q. Can you give us no examples of such suggestions as you stated you have made to operators in such cases? A. No, I could not, for the simple fact that most operators have their own ideas about that. I can't recall any instance, where I told them a set rule or gave them any instructions to follow.

Q. You do know, though, that in order to satisfactorily conclude the acidization of a well, that the spent acid, if it is there and be removable, must be removed, do you not know that to be a fact? A. Surely, it should be removed. I know that from practice.

Q. And you do know, as a matter of fact, that the spent acid is removed, be it removable from a well after it has been acidized, whether you acidize it or anyone else, is that correct? A. Here is the thing, a lot of wells are put on production and that acid water is removed right along with the production. They do not make any attempt to clear up that acid water before they put it on production.

Q. When spent acid is removed from a well, do you know what operations are performed to get it out of the well? A. It is usually swabbed.

Q. Will you explain how that acid is gotten out of

the well by swabbing? By that, I mean how is the spent acid gotten out of the well by swabbing? A. After the operator determines the shut-in period, and after he leaves it shut the length of time that he had decided upon, I presume you know what a tubing swab is; well, they merely swab that tubing down until they have swabbed sufficient fluid to carry out the spent acid. In some cases they, of course—most cases, the spent acid is noticeable when it comes back, and after that spent acid has been swabbed back, they then proceed to put the well on production.

Q. Then you are familiar with the methods of removing spent acid after acidizing? A. Surely.

CROSS EXAMINATION

When I am treating a well for the Halliburton Oil Well Cementing Company, right after I have put the acid in, that is, after I have pumped the acid into the well, I then pump the flushing oil in the well right behind the acid. After that, I am finished with the treatment.

RE-DIRECT EXAMINATION

By Mr. Conner:

Q. You stated that after you have finished putting the oil in on top of the acid and place the acid, that you are then through with the acidization of that well, is that your statement? A. That is correct.

Q. What will keep the oil in the tubing and in the casing? Are there any closures made by way of valves? A. There is always a tubing gate on the tubing.

Q. Is that tubing gate closed? A. The tubing gate is closed until we have broken off our connections, then the operator, it is up to him whether he wants to go ahead, let that come back immediately, or whether he wants to let it remain in that well for some length of time. It is immaterial.

Q. Is there also a tubing gate on the casing—would

it not be necessary to have the tubing gate on the casing closed to keep the acid and oil in place? A. That is right.

Q. Then, when you break your connections from the tank and tubing to leave, before you can do that, the tubing gate on the tubing must be closed first, must it not? A. Yes, sir.

Q. Now, it is necessary, is it not, to close that tubing gate and close the casing gate valve in order to keep the acid in position? A. That gate is merely closed after we finished treatment, for us to break away connections.

Q. I am not asking who closes it, but I ask you, is it not a fact that it is necessary to have the casing shut in and the tubing shut in after you have put that acid and oil in the well? It is necessary to have those two valves closed in order to keep the acid and oil in its proper place and effect acidization in the well? A. That is very true, but after the acid is pumped in there, there are some formations that it is complete the minute that acid is pumped in the formation. It is the general practice in lots of places that the operators remove that as soon as it is pumped in. There is no shut-in period.

Q. When there is a shut-in period, is it not then necessary to keep those valves, namely, on the tubing and casing, closed? A. That is right.

Q. When you are pumping oil into the well on top of the acid, there is this connection between your pump and the source of oil and the tubing, of some sort, is that not right? A. That is right.

Q. Now, you have put in sufficient oil, as you have computed it to be necessary, and you are to break your connections, go on home and eat dinner, who, as a matter of fact, unhooks your connection from the well? A. Usually my employees, those under my supervision, sometimes the employees of the operator.

Q. Then, who closes the valve on the tubing before the connection is broken? A. That is either one of the operator's employees or myself and crew.

Q. Then, in some instances it could be yourself or one

of your helpers who does close the valve on top of the tubing? A. It is possible, but we are working under the instructions of that operator.

Q. You said, though, did you not, that sometimes you did that? A. That is right.

Q. Is that also true with the valve on the casing? A. It is.

Q. It is already closed, is it? A. It is already closed.

Q. In connection with the stage treatment, for instance, a two-stage treatment, is the acid left in the well any length of time, when the acid is put in in the first stage? A. Well, that all depends upon the operator, whether he wants to let it stay or swab it right out.

Q. Assuming you are treating a well in two stages, and doing it all in one day, when the first batch of acid constituting the first stage is put in the well, do you withdraw that first batch? A. In some cases the operator does, in some cases he does not.

Q. In the cases where the operator does not withdraw it, who does withdraw it? A. It is usually the operator or one of his men there. On stage treatments, usually the first stage is considered, you know, kind of immaterial as to leaving it stand and it is usually swabbed right back out.

Q. Now does the operator know it should be swabbed back out if you don't tell him to? A. Well, now, that is the operator's business. Here is the thing, nearly every operator, especially any operator that has any production at all, has a man that he depends on for that purpose.

Q. Well, acidizing is your business, is it not? A. That is right.

Q. Isn't that two-stage acidization of the well one of the services you offer? A. That is right.

Q. One that you recommend under certain conditions? A. Well, of course we could recommend it, very true.

Q. You do give two-stage treatments? A. That is right.

Mr. Owen: Then we will put the large bunch, beginning with 6581 in as Exhibit 17, twelve tickets.

And the four tickets which are not a part of the large bunch will be offered as Exhibit 18, four tickets.

(The tickets referred to were thereupon marked Plaintiff's Exhibits 17 and 18, respectively.)

The Court: That is right. And the objection goes to PX-18 and I overrule it and admit it.

PAUL G. SHELLEY,

a witness called by plaintiff, testified as follows by deposition:

DIRECT EXAMINATION

I live at Midland, Michigan, and have been in the employ of The Dow Chemical Company as a research chemist since October, 1936. My work has to do with oil production in general, but especially with acidizing development, developing techniques, and methods and solutions used in acidizing wells. The majority of it has been laboratory work, but I would say at least 25 per cent of it has been field work.

I am familiar with the methods of acidizing oil wells to increase production by using hydrochloric acid and I have observed acid treatments given to oil wells located in most of the Michigan oil fields, Greendale, Porter, Allegan, West Branch, over west of Grand Rapids, and also down in Clay

County, Illinois, and in Louisiana. I have treated a dozen or two or more wells with acid to increase their production.

I have witnessed the Halliburton Oil Well Cementing Company acid treat wells owned by the Weber Oil Company, the Stella Wilcox Well No. 3 treated on August 5, 1938, the Robert Zahn Well No. 2 treated on August 19, 1938, and the Crawford Well No. 5 treated on September 10, 1938. These wells were located in Ogemaw County, Michigan, and were all given acid treatments by the Halliburton Oil Well Cementing Company. I was present and observed the treatment of all of these wells.

With respect to the Wilcox well which was treated on August 5, 1938, I went over to the well about seven o'clock in the morning. The driller, Stanley Hamilton, was there. We swabbed the well a few times. I found out at that time they had a packer set, a pipe which was about at the pay—about 2600 feet deep, I believe. About 8:30, I guess it was, the Halliburton men came to the well. The treater, Carl Nicholas, came in a coupe with the Halliburton name on it, then there was an acid truck and trailer, carrying 2000 gallons of acid, also a Halliburton piece of equipment that came at the same time, driven by a driver whose name I believe was Harold Aspin. Nicholas asked, as soon as he got there, to see if the well was swabbed dry; he checked the annular space, opened up the casing head, poured a little water in it, found it was full, plugged it up and made the connection. Then they made connections from this part of the pump to the tubing head, connected up the cable from the truck to the tubing head. The first thing they pumped about 10 gallons of some stuff that they called blanket into the tubing and then immediately followed that with acid, and continued to pump acid until they had pumped the entire 2000 gallons into the well. The first part of the acid, about 1500 gallons, went in on vacuum; the last 500 pressure started to build up and they had about 600 pounds pressure on the tubing. Then when the acid was all in, they switched to oil and pumped I believe 25 barrels of oil in that well as a flush. That went in at 600 or 700 pounds. When that was

done the treatment was over and Mr. Nicholas advised that they leave it shut in for an hour or so. The Mr. Nicholas I refer to was a Halliburton treater and he was in charge of the job. Mr. Nicholas advised either J. E. or W. L. Steelman that the well be shut in for a while. I was present and heard the conversation. I don't remember exactly what Mr. Nicholas said, but that is what he advised and that is what they did. During the treatment of this well, I was present the entire time; also present were J. E. Steelman, W. L. Steelman, Stanley Hamilton, and the two Halliburton men, Nicholas and Aspin.

With respect to the Robert Zahn well which was treated by Halliburton on August 19, 1938, I did not witness the entire treatment of that well. As I remember it was a sort of three-stage affair and I saw only the first stages of it. I was present when the Halliburton men put acid into the well. I went over to the well in the morning. Ralph McCannon was a driller on that well. Pretty soon the Halliburton boys came to the well. Nicholas came in a Halliburton coupe; a couple of other fellows I had never seen before came in the Halliburton coupe. I later found out their names were Anthony and Swain. The acid came in a Halliburton truck and trailer, 2000-gallon capacity outfit. It was driven, I believe, by a fellow by the name of Campbell. They checked the casing, annular space again, put a gauge on it, hooked their cable up from the truck to the well head, and pumped about three gallons of this blanket in first and immediately followed that with 250 gallons of acid. Then they followed that with oil. I believe they pumped about 11 barrels of oil on top of that. They got up a little pressure getting the last of that oil in. Then they recommended that the well be shut in for over the noon hour is what it amounted to. About one o'clock they came back and directed McCannon and me to start swabbing the well, which we did, and swabbed it down to about as dry as we could get it, hooked the pipe back on to it, pumped in about 500 gallons of acid, and flushed the tubing again with oil to the tune of about 12 or 14 barrels. Just about that stage of

the game is when I left. I stayed there possibly for a little bit of the swabbing. A swab is a little rod with rubber cups on it you run down the well. You run it down on a cable, goes through the fluid and when you pull it back out it has valves in it which close and this raises the column of fluid in the well. It is about the same as either producing a well or getting the fluid out of it. During the treatment of this well, W. L. Steelman was present most of the time and J. E. Steelman was present off and on, and that was also true with respect to the Wilcox well. There were conversations between the Halliburton representatives and the Weber Oil Company representatives which had to do with putting the well back on production. Mr. Nicholas made about the same suggestion as before, namely, that the well be left for a period of time, about an hour, as I recall, before they started swabbing again. He made that statement either to the driller or W. L. Steelman, I don't remember which, but I do recall that such a statement was made by Nicholas.

I was present during the entire time that the Weber Oil Company's Crawford Well No. 5 was being treated by Halliburton on September 10, 1938, and I observed the treatment. I went over to the well about seven or seven-thirty in the morning, and Ralph McCannon, the driller that had been on the Zahn well, was over there, and also a fellow helping him, and shortly after that W. L. Steelman came to the well. We changed the casing head and hooked the thing up so it was ready to be treated. Shortly after that Nicholas came to the well with his Halliburton coupe. Then he and Mr. Steelman left the well and went back to try to get the truck and trailer out of the mud, which took them until about ten-thirty. Finally they got it over there and they hooked the pump up to the well head, and hooked a section of the pump to a tank of oil sitting there about 100 feet away from the well, and started to pump oil into the tubing with the casing open. This well didn't have a packer. They continued to pump oil until the well was full, as evidenced by oil coming out of the casing head. That took about 41

barrels of oil. Then they mixed their blanket, or else it was already mixed—I don't remember specifically on this well —and pumped about 10 gallons of blanket into the tubing. They followed that with 450 gallons of acid and then they shut down for about five minutes, according to Nicholas, to let the blanket drain out and get down to the bottom of the well; then pumped another 10 gallons of acid to fill up the space in the well over the pay formation, all this time circulating oil back to the casing head. I forgot to mention they had a line from the casing head back to the oil storage tank. They continued to pump acid at a very slow rate with about 200 or 300 pounds on the tubing, with about 700 or 800 pounds on the casing, until they had pumped the entire 2000 gallons of acid into the well. Then they went back on oil, flushed the tubing with about 12 or 14 barrels of oil on top of the acid. At the end of that pumping, the pressure on the tubing and casing was equalized to about 700 pounds. The 450 gallons of acid was of such volume that it was calculated to just fill the tubing. I don't know exactly what the depth of the tubing was, but it was somewhere around 1600 feet, and that is close to the volume of acid it takes to fill the tubing at that depth. At the conclusion of this well treatment, Mr. Nicholas said he would leave the well set there a couple of hours and then put it back onto production. This statement was made to Mr. Wesley Steelman or Mr. McCannon. I cannot remember which, but I was present when Mr. Nicholas made this statement.

In the treatment of all three of these wells, the blanket was introduced into the bottom of the well. It was put into the tubing ahead of everything else and was pumped to the bottom. The blanket was put into the well in each instance before the acid, and that is true of all three treatments.

While present observing these three treatments, I noticed that Halliburton had an electrical cable hooked up in each instance. I don't believe I mentioned that on the Crawford well, but during the pumping of the 450 gallons of acid I was talking about, they got the cable out, and strung it to the tank and connected it to the tubing head. Such a

connection was made at some time or another during my stay at all three of these well treatments. This connection consisted of about one-half inch copper cable with rubber insulation. The cable connected the tubing head to the tank, so far as I could see, and it was also connected to something on the tank. That is, one end of the cable was connected to the tank, and the other end to the tubing head. Of the men I have mentioned, Nicholas, Swain and Campbell were Halliburton representatives, while J. E. Steelman, W. L. Steelman and McCannon worked for the Weber Oil Company. I am able to remember the exact details of the treatments of these three wells because just as soon as I came away from a treatment I wrote it up while it was fresh in my mind, and I have had access to those notes to keep my memory fresh.

The way in which I happened to be present during the treatment of these wells, the Wilcox, Zahn and Crawford, was that Mr. Conner asked me to go to these jobs and see if I could find out what was going on, to watch the treatments and get samples of the materials put into the wells if possible. Apparently through Mr. Conner's arrangement, I made contact with J. E. Steelman, the Weber superintendent in that district, and it was all right with him so I went out to the wells. I was present during the treatments of these wells for the purpose of observing the treatments and obtaining samples.

I obtained samples of acid used in treating the Crawford well on September 10, 1938. Before Halliburton started to pump any acid into this well Mr. Steelman brought a couple of one-gallon stoneware jugs over to the well and asked Nicholas if he would fill them up for his father, J. E. Steelman. The jugs sat around there for a while. During the period when they were circulating their tanks to mix some of the ingredients they put into the acid, they opened up a little auxiliary suction line on the pump and drained the acid into the jugs. Along towards the latter part of the afternoon J. E. Steelman came over to the well, picked up the jugs, and took them away. I saw

J. E. Steelman obtain that sample of acid. I saw the whole thing; everything that happened. Later I obtained possession of the acid sample. After the treatment was over, I went to J. E. Steelman's house where he had taken the jugs of acid. There I met E. C. Hardy, a Dowell engineer, and in Hardy's presence Mr. Steelman turned the jugs of acid over to me. I split the sample of acid into four samples which I put into half-gallon glass-stoppered bottles and proceeded to seal the samples and to label them as to what they were and where they came from. I wrote the labels out myself and they bore my signature as having witnessed the taking of the sample. I think Mr. J. E. Steelman also signed the label as having taken the sample and probably W. L. Steelman as having witnessed that, but I cannot be too sure. The labels stated that the contents were samples of hydrochloric acid which were obtained from the Halliburton trucks on the treatment of the Crawford Well No. 5, treated September 10, 1938, and that the contents were samples of the materials put into the well by Halliburton. The containers into which these acid samples were put were two one-gallon stoneware jugs, and when the samples later that day were turned over to me by J. E. Steelman, they were in exactly the same containers as when he took them, namely, one-gallon stoneware jugs. After receiving these samples and putting them in four half-gallon glass-stoppered bottles and labeling them, Mr. Hardy and I brought them to Midland, Michigan, and got in touch with Mrs. Rose Gilroy of Mr. Campbell's office. She came to the office and opened up the vault and locked the samples in it. That was done on the same day, September 10, 1938.

When the Weber Oil Company's Zahn Well was treated by Halliburton on August 19, 1938, I also obtained samples of the acid used by Halliburton in treating this well. At J. E. Steelman's house we again met Mr. Hardy and I proceeded to transfer the acid into half-gallon glass-stoppered bottles and sealed and labeled them. I labeled these samples as being hydrochloric acid obtained from the truck tank of the Halliburton acidizing truck on August 19, 1938,

during the treatment of the Robert Zahn Well No. 2. I signed that label myself, I think, as having taken the sample. W. L. Steelman was there at the time we got the sample and he witnessed it. This acid sample which was obtained when the Zahn well was treated was in my possession all the time. I requested the sample, saw it taken, and had it in my possession all the time.

When the Weber Oil Company's Wilcox well was treated by Halliburton Oil Well Cementing Company on August 5, 1938, we obtained samples of the acid used by Halliburton in treating this well. In this instance J. E. Steelman brought his two one-gallon stoneware jugs over to the well and asked Nicholas if he would fill them up. They were filled right out of the Halliburton tank on the truck. That was before they had ever pumped any acid into the well. This was in the morning. I can't remember who took the samples away, but they were taken to J. E. Steelman's house and transferred to glass bottles, sealed and labeled, the same as the others. In both cases, I think it was the Halliburton driver who took the acid sample out of the Halliburton tank. Either W. L. or J. E. Steelman, I don't remember which one, transferred the acid samples from the well site over to J. E. Steelman's house, where I then put the samples into bottles and labeled them as hydrochloric acid obtained from the Halliburton truck on August 5, 1938, and being the same as the material furnished by Halliburton and put into the Weber Oil Company's Wilcox well. I signed the labels and one or the other of the Messrs. Steelman also signed them.

The samples obtained on August 5, Mr. Hardy and I brought to the office of The Dow Chemical Company at Midland, Michigan, and turned over to Mrs. Rose Gilroy, who locked them in the office vault in our presence. In each instance, the bottles used were brand new bottles which we had procured from the stock room in the Dow Plant. They were new bottles and absolutely clean. I know that the stoneware jugs in which the samples were obtained at the well were clean because I washed them out every time I used them.

With respect to the samples obtained on August 5, 1938, when the Halliburton Oil Well Cementing Company treated the Weber Oil Company's Stella Wilcox No. 3 well, I transported those samples to Midland, Michigan, on that date and I believe I turned them over to Mrs. Rose Gilroy. Likewise, when the Weber Oil Company's Crawford Well was treated on September 10, 1938, by Halliburton Oil Well Cementing Company, I transferred those samples to Midland, Michigan, on that date and likewise turned them over to Mrs. Rose Gilroy. On August 19, 1938, when the Halliburton Oil Well Cementing Company treated the Weber Oil Company's Robert Zahn well and I obtained samples of the acid used, I transferred these samples to Midland, Michigan, and that night locked them in Building 280 at the Dow Plant, and on August 29, 1938, I deposited these samples in the vault of The Dow Chemical Company's office at Midland, Michigan. At that time I think I turned them over to Mrs. Rose Gilroy. It was in the daytime and Mr. Conner and I took them over to the vault. When samples were obtained from the Zahn, Wilcox and Crawford wells, I saw that the samples were deposited in the main offices of The Dow Chemical Company at Midland, Michigan.

I had something to do with samples of materials which were marked Nos. 14 and 20. These were samples that were brought to the office in glass jars. I do not know exactly when these samples were brought in, but one set had a date on the label of August 18, 1938, and the other set bore on the label the date of December 6, 1938, I believe it was. They were samples of hydrochloric acid, which, according to the labels, had been obtained from the north and south storage tanks of the Halliburton Oil Well Cementing Company's station at Mt. Pleasant, Michigan. These labels were signed by Mr. Day and Mr. Forsman. There was a total of four samples, two marked August 18, 1938, and two marked December 6, 1938, coming from both the north and south tanks on each of these days. I transferred these samples into glass bottles so that they could be sealed, and relabeled them and signed the labels as having made the

transfer. I do not recall anything about who may have brought the samples to the Midland office. I simply relabeled them. The label I applied to these bottles carried my signature. The data which I put on these labels I obtained from a sticker on the jar in which the sample was originally contained and which identified the sample. So far as I know, Mr. Conner gave me those samples for the purpose of rebottling and relabeling.

CROSS EXAMINATION

When the Wilcox and Zahn wells were treated, a packer was employed. I know that because it was common knowledge that there was a packer on these wells. The packer was on the tubing and the acid went below the packer, so that if the packer held in these Wilcox and Zahn wells, the acid would not come in contact with the casing pipe. The first 1500 gallons of acid went in pretty fast, but the last 500 gallons went in slowly. I would say that the acid was in contact with the tubing at least an hour. In the only treatments I saw on the Zahn well, the acid would not have been in contact with the tubing over an hour or two.

Two sets of the acid samples obtained came directly from the Halliburton truck tanks. The other set of acid samples was taken when they were circulating. They had used Klersol, and had circulated the tank for at least five minutes and were in the process of mixing Klersol into the truck or trailer tank. Somebody said this would be a good time to get the sample. They opened up the drain. This was on the Crawford well.

By Mr. Babcock:

Q. I want to know whether the sample would be truly representative of what Halliburton hauled out to the well or whether it would be contaminated by, say, some of the oils, mercaptans, or other things in the well? A. There is no question of that in my eyes. Two of the samples came out of the tank, the other acid sample came out of circulation

from the bottom of the tank. There would be no possibility for any contamination of any sort.

We used the same stoneware jugs each time. The first time we used them they were brand new, and as we finished transferring the acid from them we washed them out good, stoppered them, and put them away until we got ready to use them again. Whether they were rinsed again I do not know. These stoneware jugs had never been used for anything else in their lives from the time they were new until they got into this deal. I do not know whether the samples of acid I took were samples of inhibited acid or not. I had nothing to do with the testing of this acid.

In the Wilcox, Zahn and Crawford wells, oil was being produced from the Dundee formation in two of these wells, and I am not sure whether it was being produced from the Dundee or Traverse in the other. I believe it was from the Dundee formation in all of them. The Traverse formation is also limestone. Previous to the three well treatments to which I refer, Halliburton Oil Well Cementing Company had made one other well treatment for the Weber Oil Company that I know of.

The Messrs. Steelman that I refer to are father and son, and I would definitely say that they were oil men. The Weber Oil Company's driller probably knew something about oil. I do not think that Mr. Nicholas had to instruct the Weber Oil Company's representatives with respect to treating these wells. I think Mr. Nicholas offered information as a suggestion which the Weber men were perfectly willing to follow. Even though they are oil men, it is sort of general practice for most oil men, especially smaller outfits, to pretty nearly accept the recommendations of the acidizing or service company as to what they are going to do to a particular well. My impression is that they feel like the service companies know more about treating their well than they do, from the service end of it.

Q. How do you regard the statements of Nicholas as to how long the well should remain shut in after the acid was introduced, as to what he thought to be the best practice? A. Well, it was a little more than that, although I

feel, absolutely, if either of the Messrs. Steelman had had any instructions from Weber Oil Company, they probably would have followed those in preference to Nicholas' suggestions. Nicholas made the statements in such a way it appeared he intended the well to be shut in as he said.

This conversation between Nicholas and the Weber Oil Company's representatives took place at the Zahn well, between the stages of treating it. It was noon and they all left and went to lunch during the shut-in period. The second time Mr. Nicholas suggested that the Zahn well be shut in, I was there and it was during the second shut-down period of the Zahn well treatment. I stayed there and just started to swab the well when Mr. Steelman came and said, "Let's go." On the Crawford well the treatment was all over and they left. I left too. The well was necessarily shut down because it would take them longer than that to run the rods into the well and get the well to produce. They didn't start to do that immediately.

I have no knowledge of what happened on any of these wells after the acid was placed into the well and after Halliburton left except in the case of between the stages of the treatments on the Zahn well. I don't know what happened on the other wells. On the stage treatment of the Zahn well, the acid was forced into the formation, withdrawn, and then a new batch of acid was forced in and withdrawn. The spent acid was removed at the end of the first stage by swabbing the well for about an hour until we couldn't get any more fluid out of the well. I do not know how much spent acid we got out of the well. Mr. McCannon of the Weber Oil Company and I did the swabbing.

When the Weber Oil Company's Stella Wilcox well was treated August 5, 1938, by the Halliburton Oil Well Cementing Company, the acid in the tank was not circulated or stirred up, and we got the sample of acid out of the truck tank in the morning, before Halliburton had pumped any acid into the well.

By Mr. Babcock:

Q. So, in your opinion, there couldn't have been any

contamination, no mixture of acid? A. No, not in that case, or any of them, but specifically it wasn't possible for anything to be in that jug that wasn't in the tank. There may have been oil in the tank they had gotten somewhere else—I don't know anything about that, but so far as the acid that went into the well it was the acid that Halliburton brought to the well.

Q. Did you look into the tank? A. I think so, yes.

Q. But you don't remember whether there was any oil on the surface of the acid or on the walls of the tank? A. Well, I just can't be absolutely sure about it. I just didn't have that in mind at the time. There probably was skim oil on it. You can hardly find a tank that there isn't skim oil on it.

Q. Is it customary in these acidizing jobs to circulate oil through the tanks sometimes? A. Well, sometimes it is customary to get oil in the tank, sometimes in the pumps. You pump oil to flush your pump out after you finish, flush the tubing, and then flush the pump. You drain it but if you are trying to establish the fact there is the possibility there may have been oil in the tank, the answer to that question is yes. It is impossible to keep all the oil out unless you bring the acid all in glass jugs. There was nothing taken from this treatment except the material that got into the jug.

Q. On the Crawford well was the same pump and same tubing used to circulate the acid that was used in the treatment to pump the oil? A. Same pump.

Q. Same tubing too? Part of the same tubing? A. No, they usually hook another hose on the side of the tank, circulate it. They make pipe connections from the well.

When the Weber Oil Company's Zahn well was treated by Halliburton Oil Well Cementing Company on August 19, 1938, the acid samples were obtained in the interval between the two stages of treating this well. The acid sample was given to me by one of the Halliburton men, upon request, who took it from the manhole of the Halliburton truck tank. On this well we did not swab any oil or acid back into the

Halliburton truck tank. We did not circulate the acid back into the Halliburton tanks. We didn't circulate anything back into the Halliburton tanks. The procedure on the Zahn well was to pump 3 gallons of blanket into the well, which was followed by 250 gallons of acid, then followed by about 10 or 12 barrels of oil. The well was then shut down for a while after which it was swabbed, but we swabbed back into the Weber Oil Company's lease tank. It was not a matter of circulation, it was a matter of cleaning the well out to get the spent acid back by swabbing it out. The spent acid went into the Weber lease tank. Then, on the second stage of the treatment of this well, more blanket was put in, about 5 gallons of blanket and 500 gallons of new acid and we did the same thing over again. The oil that followed the acid went back into the Weber lease tank. (Witness refers to notes.) On the second stage of this treatment we did exactly the same thing. A sample of the acid was taken between the two stages. It was then taken out of the Halliburton truck tank. Never had there been any opportunity for anything to get into the Halliburton truck tank at all. In other words, the material in the Halliburton truck tank didn't have any opportunity to be contaminated with anything that had been in the pump because nothing circulated from the pump back into the Halliburton truck tank. This Zahn well was the instance where I asked the Halliburton man to get the acid sample out of the Halliburton tank.

With respect to the acid sample obtained when Halliburton treated the Weber Oil Company's Crawford well on September 10, 1938, the sample was taken before any acid was pumped and during a period of circulation. Whether it was taken before or after pumping oil I would not know. (Witness refers to notes.) The acid sample from the Crawford well was taken after the oil had been pumped. This sample was taken from the pump after we had finished pumping oil and had circulated the tank. A blanket was also used in this treatment. The blanket was put into the well and then followed with acid. There was no packer

in this Crawford well; the well hole was filled with oil prior to the treatment, and we forced the oil into the well to place the blanket into position and circulated the oil back into the lease tank by means of the Halliburton pump. Then, with the Halliburton pump, we pumped oil from the lease tank into the well tubing until the casing, tubing and all of the well was full of oil. Then, I think it was that we started mixing up the acid, but I cannot be too sure of that until I check. (Witness refers to notes.) Yes, we finished pumping oil and then mixed chemicals and circulated them with the Halliburton pump. This circulation consisted of taking suction out of the bottom of the Halliburton tank and running the acid through the Halliburton pump and back into the Halliburton tank it came from.

RE-DIRECT EXAMINATION

As to how long the acid was in contact with the tubing during the treatment of the Crawford well, four hours would be within 20 per cent right. I would absolutely say, with respect to all the acid samples I obtained, that there is no doubt but what the samples were absolutely representative of the material that went into the oil wells. Had I not taken the samples of acid coming from the Halliburton tanks, that same acid would have been put into the oil wells.

RE-CROSS EXAMINATION

By Mr. Babcock:

Q. In the Crawford well, it's a cinch, as far as I can see, what went into the well from the Halliburton tank wasn't only some acid but also some oil that came out of the well, isn't that true? A. Well, that's possibly true, yes. There might have been a little oil left in the pump.

Q. I am only speaking of a little, but it's a cinch some oil that was circulated got into there? A. Yes, you open up the drain, there is some oil that sticks in the pump, a little oil held up over the valves. It would be silly to maintain the acid was absolutely completely oil-free.

JOSEPH E. STEELMAN,

a witness, called by plaintiff, testified as follows by deposition:

DIRECT EXAMINATION

I live at West Branch, Michigan, am an oil field superintendent for the Weber Oil Company of Bay City, Michigan, and have worked for them since July 30, 1933. My duties include superintending the drilling and producing of crude oil for the Weber Oil Company, and I have charge of the Weber Oil Company's wells in Ogemaw County, Michigan, and elsewhere.

It is the practice of the Weber Oil Company to have its wells treated with acid and this work has been done by Dowell Incorporated and Halliburton Oil Well Cementing Company. The Weber Oil Company owns and operates in Ogemaw County, Michigan, wells known as the Wilcox No. 3, Zahn No. 2 and the Crawford No. 5. My records show that Halliburton Oil Well Cementing Company acid treated the Stella Wilcox Well No. 3 on August 2 and August 5, 1938, the Robert Zahn Well No. 2 on August 19, 1938, and the Crawford Well No. 5 on September 10, 1938.

On August 5, when the Stella Wilcox Well was acid treated by Halliburton, Paul Shelley received from me samples of the acid used in treating that well. The acid sample was taken out of the tank by one of the Halliburton men, I believe, and handed to him. I took the samples to my garage so that they wouldn't be broken or destroyed at the well and gave them to Paul Shelley. He took the samples from my garage, which was not probably more than an eighth of a mile from the well, and it was there at my garage that I gave the samples to Shelley.

Again, when Halliburton treated the Zahn well on August 19, we obtained samples of the acid used. I took the sample home to take care of it until Shelley came and got it. In each instance when I took the sample from the well

to my house, the sample did not leave my possession until I gave it to Mr. Shelley. From the time that I obtained the samples at the well and took them to my house and turned them over to Shelley, I did not add anything to them and they did not leave my possession.

I have in my possession records which will show the production of the Wilcox well before it was acidized on August 5, and also its production after it was acidized. I will give the production figures in feet and inches and also the rate of barrels to the foot, and you can do the actual figuring. On July 28 the Stella Wilcox made 1 foot 1 inch of oil in a 100-barrel tank that we estimate makes 10 barrels to the foot. On July 29 it made 1 foot even in a 100-barrel tank. On July 30 it made 1 foot. On July 31 it made 1 foot. August 1 there was no production for the reason that we had to run tubing to use in acidizing the well. On August 2 we swabbed a foot of oil, that is before you start putting the acid in. On August 3 the well made 5 feet 1½ inches in a 100-barrel tank. On August 4 it made 4 feet. On August 5 it made 3 feet 10 inches. Of course, as all acidizing men know, that figure on August 3 contained a lot of acid in there and water. August 6 production shows 10 feet 6 inches in a 100-barrel tank. August 7 shows 5 feet 8 inches. There is a blur on my record for August 8, but it looks like the well made 2 feet 3 inches. On August 9 it made 4 feet 1 inch. On August 10 all the production shows here is 2 inches in a 500-barrel tank. Now, get the difference because that 2 inches here is in a 500-barrel tank. August 11 it doesn't show any production. That is the end of the production records for that well because on August 12 they pulled the rigging down. The production records show that as a result of acid treating this well the production was increased probably by two-thirds for at least thirty days.

I have similar records showing the production of the Zahn Well No. 2, which was acidized by Halliburton on August 19, 1938. These records begin on August 6, on which date the well made 3 inches in a 100-barrel tank. On

August 5 the well made 5 inches. On August 6 it made 6 inches. August 9, 6 inches. On August 10, it made 2 inches. August 11 it made 5 inches. August 12 it made 2 inches. August 13, 4 inches. August 14, 4½ inches. August 15 it made 4 inches, and August 16 the same amount. That is the end of that period of production because we had taken down the well rigging. I have production records here that show the well was treated on August 19, 1938. The record for August 20 doesn't show any production at all. The record shows that for August 21 the production was 3 feet 2 inches, which also includes part of 1 foot 11 inches of oil put down into the well when acidizing it. The next production record I have for this well is for August 23, showing the well produced 3 feet 11 inches in a 100-barrel tank. On August 24 the production is 2 feet. There was no production on August 26 because we were pulling the tubing and taking the packer off and rearranging the pumping equipment. The next production record I have for this well is on August 15, 1938. I have no production records for this well for September as we were constructing a new tower on that well at that time and we had quite a delay. I have production records on the Zahn well which show its production after it was put on the pump. These records start with October 15, 1938, and show that on that date the well made 10 inches in a 250-barrel tank. On October 16 it made 7 inches in the same tank. October 18 it made 4 inches. October 19, 5 inches. October 20 it made 3 inches. October 23, 2 inches. October 25, 1 inch. October 26, 4 inches. October 27, 3 inches. October 28, 5 inches. October 29, 4 inches. October 30, 3 inches.

I also have production records on the Crawford Well No. 5 which show its production before it was acidized on September 10, 1938. On September 1 this well made 10 inches of oil in a 100-barrel tank. On September 2 it made 10 inches. September 3, 11 inches. September 5 it made 1 foot 5. September 6, 8 inches. September 7, 8 inches. September 8, 3 inches; we were running tubing that day. September 10 the well was acidized and we used about 5

feet of oil from a 100-barrel tank. On September 11 the well made 4 feet 1½ inches in a 500-barrel tank. September 12 the well made 3 feet in a 500-barrel tank. September 13 it made 2 feet 6 inches. September 14 it made 1 foot 9 inches. September 15, 2 feet 2 inches. The records then show the well was closed down for want of tank room.

I was present at intervals during the treatment by Halliburton of these three wells. I was at the well part of the time, what time I could spare from my daily routine duties. To the best of my memory, I was present at the conclusion of the treatments. I have many other duties in this field and on the days these wells were treated I divided my time. But I was present at least part of the time. I don't recall any conversations at the conclusion of these treatments between myself and the Halliburton men who were treating the well which had anything to do with putting this well back onto production. I don't recall hearing anything out of the ordinary whatsoever, maybe just some suggestion about how to fix the line or something. At this time I don't recall any suggestions or discussions with the Halliburton men about what next to do to the well, about bringing it back to production.

CROSS EXAMINATION

As to the kind of packer we used, it was just a rubber expanded Larkin wall packer. Halliburton did not do anything to protect our tubing from corrosion, so far as I know. If they did, I did not know what it was. I don't know how they could do anything to protect the tubing. To my knowledge, they never any of them do. Halliburton has not acidized any wells for the Weber Oil Company other than these three. I recall how I happened to select Halliburton to acidize these three wells. It was at the request of Dowell Incorporated. Also, we were interested to know if Halliburton's treatment would be any better. We are always looking for improvements.

WILLIAM S. DAY,

a witness called by plaintiff, testified as follows, by deposition:

DIRECT EXAMINATION

My address is Mt. Pleasant, Michigan, Route No. 4. I am district manager for Dowell Incorporated, whose business is that of acidizing oil wells. My territory covers Michigan, part of Ohio and Canada.

The Halliburton Oil Well Cementing Company is located in Mt. Pleasant, Michigan, and their business is also that of acidizing oil wells. That company did have two wooden storage tanks at Mt. Pleasant. They have one steel storage tank now. I saw the wooden storage tanks of Halliburton's up until about six or eight months ago. I have seen these tanks on several occasions; they were located on North Franklin Street and contained hydrochloric acid. I know this because on two different occasions I got samples out of them. These tanks set right alongside of each other, one north, and one south, which I refer to as the north and south tanks.

The first occasion I obtained samples from these tanks was on August 18, 1938. I took the samples to my office, labeled them, locked them up, and brought them to the office of the Dow Chemical Company at Midland, Michigan, where I gave them to Mr. Conner. I labeled the acid as being taken out of Halliburton's tank on that date and I had the date on the sticker. I also designated whether the sample came from the north or south tank to identify the tank to which the sticker referred. I signed the labels.

I obtained other samples from both these tanks on December 6, 1938. I disposed of these samples in the same manner as the first. These samples contained labels the same as the first samples and I signed the labels.

In each instance the sample of acid I obtained from each tank was about two or three quarts. Whatever sam-

ples I took from these tanks I delivered to Mr. Conner at Midland, Michigan. When I obtained these samples Warner Forsman, bookkeeper in our station office at Mt. Pleasant, was with me each time, and he was with me each time I delivered the samples to Mr. Conner. When I obtained these samples on August 18, 1938, and December 6, 1938, I got the samples in a new clean glass jug.

CROSS EXAMINATION

These wooden tanks had no oil around them or anything in them besides acid. They were just hydrochloric storage tanks of 250 barrel capacity. When we (Dowell) come back from the well and have not used all of the acid in our truck tank, we never pump it back into our storage tank. My recollection is that these Halliburton tanks had no oil around or in them at any time I took the samples.

I got the samples through the manhole cover in the top. No Halliburton men were there, if there had been I would have asked them for the samples.

RE-DIRECT EXAMINATION

I recognize the top picture of PX-168 as being the Halliburton storage tanks located at Mt. Pleasant, Michigan. The storage tanks depicted in that picture are the same ones from which I obtained samples on two different occasions.

WARNER FORSMAN,

a witness called by plaintiff, testified as follows, by deposition:

DIRECT EXAMINATION

I am district office manager for Dowell Incorporated at Mt. Pleasant, Michigan. I have been employed by Dowell for approximately four years. Dowell is engaged in oil well acidizing and cementing.

The Halliburton Oil Well Cementing Company have an office at Mt. Pleasant, Michigan, and are also engaged in the business of acidizing wells. On numerous occasions I have seen the Halliburton storage tanks located on North Franklin Street. I recognize the top photograph in PX-168 as being a picture of the Halliburton acid storage tanks I refer to. These tanks contain hydrochloric acid. I know this because they are similar to Dowell's tanks which are used for the same purpose. I have seen Halliburton's trucks load acid out of these tanks and we have also obtained samples from these tanks. There are two tanks. I would identify them as north and south, as one tank lies directly north of the other. I have obtained samples from both tanks on two occasions. The first was on August 18, 1938, the second on December 6, 1938. On each occasion I obtained approximately three-quarters of a gallon of acid from both the north and south tanks.

When the samples were taken, they were immediately identified as to which tank they were obtained from and they were delivered to The Dow Chemical Company at Midland, Michigan, to Don Conner. The samples were identified by labeling each sample with respect to the location of the tank. We marked the first sample we obtained in August N-14 and S-14. They were labeled over here and we signed our names to the labels indicating the tank from which each sample was obtained.

On August 18, 1938, I got a sample from both the north and south tank and these samples were put in separate con-

tainers. The labels showed the dates on which the samples were obtained and bore the signatures of W. S. Day and Warner Forsman. Similarly in obtaining the samples on December 6, 1938, each bottle was labeled in a like manner and bore my signature and that of Day. After obtaining these samples on both occasions they were brought to Dowell's office, and delivered to The Dow Chemical Company's office within ten hours from the time they were obtained and delivered to Don Conner.

CROSS EXAMINATION

Q. How did you obtain these samples? A. They were obtained in a clean glass jar.

Q. I mean did you get them out of the top of the tank? A. Yes.

Q. Who climbed up on top of the tank? A. I guess I did.

Q. Did you put old clothes on? A. I was working around the garage. I was asked if I wanted to go down the street. I said yes. I didn't have any clothes for it.

Q. What do the tanks look like? A. Wooden storage tanks.

Q. Any oil on them, around them or in them? A. I didn't notice any oil.

Q. How did the acid look? Did it look clear and clean? A. Yes.

Q. What time of day was it? A. I don't remember exactly. It was probably, oh, around dusk, probably eight or nine o'clock.

Q. Eight or nine o'clock in December in Michigan you can see what acid looks like in a tank? A. No. It might have been later than that. I don't remember the exact time.

Q. Well, you don't know what it looked like inside the tank then, do you? A. No, I thought you meant when I got the acid out. You can't, of course, see down a tank.

Q. What did you lower into the tank? A. Lowered a clean glass quart jar.

Q. Did you have it on a bail or hook or something? A. Yes.

ROSE GILROY,

a witness called by plaintiff, testified as follows, by deposition:

DIRECT EXAMINATION

I live at 1713 Sayre Street, Midland, Michigan, and am secretary to the general counsel of The Dow Chemical Company. I remember one night in August, 1938, that Mr. Shelley and Mr. Hardy and Mr. Conner met me at the offices of The Dow Chemical Company in Midland with samples in glass bottles. These samples were put in the vault of the Legal Department. Then I locked the vault in their presence. That was in August, 1938. I have a way of fixing the date because I was called away from a dinner party. The samples consisted of a number of glass bottles which were labeled. I do not know who labeled them or what was in them. The contents of the bottles were liquid.

That is not the only occasion on which Mr. Shelley, Mr. Hardy or Mr. Conner delivered samples to me. About a month or so later, these gentlemen brought another quantity of labeled glass bottles and these also were put in the vault in the presence of these gentlemen. That was in 1938. I cannot give the month, but I would say about a month or so after the first batch.

LEONARD C. CHAMBERLAIN,

a witness called by plaintiff, testified as follows, by deposition:

DIRECT EXAMINATION

I live in Midland, Michigan, and have been employed by The Dow Chemical Company since 1928 as a research engineer. During the month of June, 1939, I attended the taking of depositions at Mt. Pleasant, Michigan, in this case and obtained a piece of lead from defendant. When the depositions were over, we went to the Halliburton warehouse at Mt. Pleasant, where one of the Halliburton men gave me this lead strip. I put it in my car and brought it back to Midland and tagged it with pertinent information concerning where I obtained it and put it in the vault here in Midland. I prepared a label for the lead strip so it could later be identified, which label contained the information that this lead strip was obtained that day from the Halliburton Oil Well Cementing Company representative and that I received it and brought it to Midland. I signed the label and attached it to the lead strip. This lead strip was put in the vault in the office of Mr. Campbell.

Q. Do you know the name of the party representing Halliburton who gave you the lead strip? A. Well, there were several of them there. I think Mr. Edwards was there.

Q. Mr. Edwards is here today. Is he the gentleman? A. I think you were there (witness addressing Mr. Conner). I think Babcock and Edwards were both there.

Witness (to Mr. Babcock): Weren't you there?

Mr. Babcock: I actually don't know that we gave you one there. I mailed you one.

By Mr. Conner:

During the depositions in 1939 in Mt. Pleasant you offered us a lead strip such as is used in the tank as an

electrode, and we accepted it according to the testimony of Mr. Chamberlain.

Q. At the time this lead strip was given to you what, if anything, was said to you by any of the Halliburton representatives as to the use that they made of such or similar lead strips? A. Well, it was the remainder of a strip which they said they hung in their tanks during the polarization of the tanks.

Q. Was this a strip which had or had not been used, do you know? A. It was supposed to have been used.

CROSS EXAMINATION

I did not test this lead strip to see what it was chemically. I do not know where the lead strip is now.

DONALD L. CONNER,

a witness produced on behalf of plaintiff, testified as follows:

DIRECT EXAMINATION

I live in Tulsa, Oklahoma, and am a lawyer employed by The Dow Chemical Company, stationed at Tulsa, Oklahoma. I am the Mr. Conner to whom several witnesses have testified they delivered certain samples.

On August 5, 1938, E. G. Hardy and myself met Paul Shelley and Messrs. W. L. and J. E. Steelman at the home

of J. E. Steelman outside West Branch, Michigan. We met them late in the afternoon as I recall, and J. E. Steelman, I think, turned over to Mr. Shelley two stoneware jugs of liquid. I was present when Mr. Steelman turned these jugs over to Shelley and Hardy. These two jugs, which I was told contained liquid hydrochloric acid, were put into four one-half gallon jugs with glass stoppers and sealed. I observed Shelley write out labels for each of these four bottles of acid which had come from the jugs. The labels, which I saw him write and have observed since, showed what acid it was, where it came from, who supplied the acid, identified the well, and gave the date. Those samples were sealed. Shelley signed each one of them and Hardy signed the label in each instance, showing Shelley had sealed the sample and that Hardy was a witness to the sealing of the sample. In this case, the Stella Wilcox well, Mr. Steelman signed the label. That gave us four one-half gallon jars of acid as samples taken from the treatment of that well. I was present at Mr. Steelman's home when the jugs of acid were brought in from the well.

In each instance, when the Wilcox well was treated on August 5th, the Zahn well on August 19th, and the Crawford well on September 10th, for the Weber Oil Company by Halliburton, I was present in Mr. Steelman's yard, and either Mr. Steelman turned the samples over to Shelley or Shelley brought the sample with him. I want to correct my testimony. I was not present when the samples from the Zahn well were delivered, but I was present when the samples were delivered from the Stella Wilcox and the Crawford wells.

I had nothing to do with the preparation of the labels so far as the physical making of the labels was concerned, but I did direct Shelley as to the wording of the labels, and in each case I or Shelley wrote up in the corner of the label a key number which would then enable us to identify and refer to the sample in a more brief manner. In the treatment of the Wilcox well on August 5th, these acid samples put into the one-half gallon bottles were numbered 5, 6, 7 and 8.

I am pretty sure I was not present at the Zahn well when the samples were taken. I can find out in a few minutes by looking at the expense reports. My recollection is that I was in Oklahoma. I have knowledge of those samples to this extent: I was present in Midland, Michigan, practically all of the summer of 1938. I am pretty sure I must have been here, although I would rather look at my expense records.

(Witness left to examine records.)

My recollection has now returned and I definitely recall that I was not present during the treatment of the Zahn well. I had something to do with the marking of samples, which bore labels indicating that they came from the Zahn well. I recall that during the latter part of August, 1938, when I came to Midland on one of my trips, I contacted Mr. Paul Shelley and he had previously told me that when the Zahn well of Weber's was treated on August 19th he obtained on that date a sample of both the acid and the blanket used in the treatment of that well. Shelley contacted me and together we went into the plant of The Dow Chemical Company to Building No. 280, where we opened up a vault and took out of there some samples that he told me was acid, and some material that he told me was blanket, and we brought them over to the Legal Department office. Those samples of acid and blanket had been labeled in the handwriting of Shelley to show where the materials came from, on what date, what well, who obtained them, and sealed them, and what not. I recall that the label showed there were three one-half gallon bottles and the label said substantially that they were hydrochloric acid, part of the acid put into the Zahn well by the Halliburton Oil Well Cementing Company, and the label went on to say that it was brought to the well by the Halliburton Oil Well Cementing Company, each label was signed by Shelley to show he had sealed them and further signed by E. P. Hardy showing he had witnessed it.

Either I marked or I instructed Shelley to mark up in one corner of the labels on these acid samples, the num-

bers 12, 12A and 12B, there being three one-half gallon samples. Shelley and I, after getting them from 280 Building in the plant, brought them to the vault in the Legal Department office. I was with him when he brought them from 280 Building over to the office, and that was the latter part of August.

I was present at the time samples of acid were obtained from the Crawford well, I was present in the yard of Mr. J. E. Steelman at West Branch or I was present with Shelley and Hardy near the well. I don't recall whether it was actually Mr. Steelman's yard or some place near the well where J. E. Steelman or Wesley Steelman, one of the two, gave to Shelley those two one-gallon stoneware jugs containing the acid. We took those jugs, Shelley, Hardy and myself, and Shelley and Hardy poured the acid out of the stoneware jugs into four one-half gallon bottles, stoppered and sealed them, and prepared labels showing from which well they had obtained them, all similar to the other labels. Those samples were marked as samples Nos. 15, 15A and 15B, and I was with Shelley and Hardy when those samples were delivered to the vault of the Legal Department of The Dow Chemical Company at Midland, Michigan. This was done on the very same date, September 10, 1938, that the samples were taken. I recall that very accurately because I left town that night to go back to Oklahoma.

I had something to do with the samples of acid which were obtained by Mr. Day and Mr. Forsman from the Halliburton storage tanks at Mt. Pleasant. I requested of them some time in August that they obtain samples from the wooden storage tanks of Halliburton, which I was told had acid in them and were located on North Franklin Street, Mt. Pleasant, Michigan, on August 18. I remember that date very clearly because it was the day before the Zahn well was treated, I think. On August 19th, Mr. Day and Mr. Forsman brought to me at the Midland office of The Dow Chemical Company, two bottles containing a liquid which they said was hydrochloric acid, each bottle

having attached to it a sticker. If my memory serves me rightly, it was a white sticker with a red border around it, showing one sample came from the north tank and the other showing it came from the south tank, containing the date on which the samples were obtained, and each of those labels were signed by Day and by Forsman. At the time I first saw the bottles, I examined them and marked up in the corner that one sample that came from the north tank, as 14N, and the one from the south as 14S, and so marked that on each of the labels. On that same date, I think it was, I contacted Paul Shelley and had him come to me at the office and, at my direction, Shelley took the north and south samples, and he split them into three parts, stoppered and sealed them. In addition a label was prepared showing where they came from. That label was put on each of the three portions and Shelley signed it. On one of the portions of the sample, 14S and 14N, there was attached the original label that had been on the containers in which they were delivered. When the 14N sample was split, it was then called N-14 for the first portion, N-14-A for the second portion, and N-14-B for the third portion. With respect to the S-14 sample, when it was split the first portion was marked S-14, the second S-14-A, and the third portion S-14-B, and placed them in the vault; all done on August 19th. Later I received additional samples from Mr. Day.

On December 6th, Mr. Day and Mr. Forsman brought me two samples of what they said was hydrochloric acid in two different containers, each labeled showing where it came from and how they got it. As to those samples, I marked one N-20, showing it came from the north storage tank of the Halliburton Oil Well Cementing Company at Mt. Pleasant, according to the label they had prepared, and the other S-20. On that same day, if not the next, as in the previous case with the series No. 14 samples, we took the two samples marked N-20 and S-20, split each into three portions, the S portions being marked S-20, S-20-A and S-20-B, and the N portions being marked N-20, N-20-A

and N-20-B. On each of the six portions, there was a label prepared based on a label that was on the original container. Mr. Shelley prepared the label and signed it. On one each of the portions, we attached the label Day and Forsman originally had applied to those samples. After those samples were so marked, Shelley and I put them in the vault of the Legal Department at Midland.

CROSS EXAMINATION

By Mr. Babcock:

Q. Who has access to this vault in Building 280? A. That I don't know. It is in the Physical Research Laboratory Building so far as I remember. I have only been in the plant, oh, probably just on a very few occasions, and I wouldn't have the slightest idea who has access to that vault except Shelley. I would presume Mr. Chamberlain, his superior, would, and other than that I don't know.

REDIRECT EXAMINATION

I have a correction or addition to make to the statement in my testimony yesterday referring to a sample Day delivered to me in December, 1938, as sample No. 20: In December of 1938, Mr. Day and Mr. Forsman delivered to me two bottles of liquid which they said was acid taken from the Halliburton storage tanks at Mt. Pleasant, Michigan. These samples, both of them, were labeled when I received them from Mr. Day and Mr. Forsman and the label showed what date the samples were taken, which was December 6, 1938, the labels further showing where the samples came from and further showing who obtained the samples, and bore the names of Day and Forsman, who both then signed the labels. When I received those samples, Mr. Shelley and I, in splitting them, erroneously marked them as samples Nos. 17-S and N, and it later developed that we already had obtained a sample which we had labeled No. 17, giving us duplicate sample numbers 17.

To correct that situation, I then directed that these storage samples should be renumbered as series 20. That is, they were then numbered N-20, N-20-A, and N-20-B, and the other portion was numbered S-20, S-20-A, and S-20-B, thus making a correction to our numbering of the samples. However, this change had nothing to do with changing anything on the label, which was a true indication of where the samples came from and what not. When these samples were received by me I did not first mark them N-20 and S-20. I may have made my statement a little incorrect at first. When I first received them I marked them S-17 and N-17, A's and B's to each. Finding I already had among my samples a sample marked N-17, which I had previously obtained, I then corrected this latter set of samples, which were the storage samples, and changed their mark from the series 17 to series 20.

I don't recall the exact time interval after the original marking of the N and S-17 numbers and when I changed them to N-20 and S-20. However, I think it was a very short period of probably two or three days. I then and am now keeping a constant chart of numbers I applied to the samples and I think when revising the list as to the numbers, I found I had already numbered one 17. So I would say roughly it was within two or three days.

Mr. Lyon: I just want to make a remark. Counsel for the plaintiff has now offered the depositions of ten witnesses in regard to formal matter, that is, the obtaining of samples on these four wells which were the subject of a discussion this afternoon, and although these witnesses are available in the district, I am willing that their depositions should be taken with the same force and effect as if they were called to testify, but I would like to reserve my objection to this testimony, the same objection that I am making on this subject.

The Court: You may have that, and I will overrule it and you have an exception.

Mr. Owen: Now, the next step, Your Honor, pertains to the transmission of these samples, which by these depo-

sitions were traced to the vault of The Dow Chemical Company—the next step is to get them from The Dow Chemical Company into the hands of Dr. Bartell, our expert. We have here some affidavits of some men that they delivered them to Dr. Bartell and his affidavit that he received them.

Mr. Lyon: I am willing that these affidavits should be received in evidence with the same force and effect as if the witnesses named in the affidavits were called and testified to the facts in the affidavits.

The following affidavits of Leonard C. Chamberlain, Donald L. Conner, Edward C. Hardy and Floyd E. Bartell were offered and received in evidence.

AFFIDAVIT OF LEONARD C. CHAMBERLAIN

I am a resident of Midland, in the County of Midland, State of Michigan, my address is Isabella Road, and I am employed by The Dow Chemical Company at Midland, Michigan as a research engineer.

On July 6, 1939, and August 31, 1939, upon instructions from The Dow Chemical Company, Legal Department, I removed certain packages and glass bottles containing samples of materials from the vault in the main office of The Dow Chemical Company at Midland, Michigan, and transported them to Ann Arbor, Michigan, where I delivered them to the office of Dr. Floyd E. Bartell, Department of Physical Chemistry, at the University of Michigan.

AFFIDAVIT OF DONALD L. CONNER

I am a resident of Tulsa, in the County of Tulsa, State of Oklahoma, my address is 215 East 27th Street, and I am employed by The Dow Chemical Company of Midland, Michigan, as a lawyer.

On August 24, 1938, and April 25, 1939, I removed certain glass bottles containing samples of materials from the vault in the main office of The Dow Chemical Company at Midland, Michigan, and transported them to Ann Arbor, Michigan, where I delivered them to the office of Dr. Floyd E. Bartell, Department of Physical Chemistry, at the University of Michigan.

AFFIDAVIT OF EDWARD C. HARDY

I am a resident of Mt. Pleasant, in the County of Isabella, State of Michigan, my address is 503 East Chippewa Street, and I am employed by Dowell Incorporated as station manager at Mt. Pleasant, Michigan.

On September 15, 1938, upon instructions from The Dow Chemical Company, Legal Department, I removed certain glass bottles containing samples of materials from the vault in the main office of The Dow Chemical Company at Midland, Michigan, and transported them to Ann Arbor, Michigan, where I delivered them to the office of Dr. Floyd E. Bartell, Department of Physical Chemistry, at the University of Michigan.

AFFIDAVIT OF FLOYD E. BARTELL

I am a resident of Ann Arbor, in the County of Washtenaw, State of Michigan, my address is care of the University of Michigan, and I am Professor of Chemistry at the University of Michigan located at Ann Arbor, Michigan.

I was in Midland, Michigan, at the office of The Dow Chemical Company at various times within the last several years and there on the dates indicated received from the Legal Department of The Dow Chemical Company samples of various materials bearing the numbers as follows:

No. 5	August 23, 1939
No. 6	August 23, 1939
No. 8	August 8, 1938
No. 12	August 23, 1939
No. 15	August 23, 1939

Additionally I have received from various persons of The Dow Chemical Company other samples of materials bearing certain numbers which were delivered to me at my office at the University of Michigan at Ann Arbor, Michigan, by the persons and on the dates indicated:

No. 12-B, August 24, 1938, delivered by D. L. Conner.

No. 15, August 31, 1939, delivered by L. C. Chamberlain.

No. N-14-B, September 15, 1938, delivered by E. C. Hardy.

No. S-14-B, September 15, 1938, delivered by E. C. Hardy.

Additionally, on December 14, 1938, I received samples of material marked Samples Nos. N-17-B and S-17-B from The Dow Chemical Company which samples came to me by express.

DR. FLOYD E. BARTELL,

a witness called by plaintiff, testified as follows:

DIRECT EXAMINATION

I am Professor of Chemistry at the University of Michigan, occupying the position since 1910. In this position I am responsible for the work of the department of general and physical chemistry, conduct classes in physical chemistry including colloid and surface chemistry, and direct the research of numerous graduate students. I have a Bachelor's Degree, a Master's Degree and the Degree of Doctor of Philosophy, the last two from the University of Michigan.

I have had numerous occasions to study patents and am familiar with the Grebe-Sanford patent 1,877,504, having studied it in connection with my work in this case. I understand the patent to relate to the treatment of deep wells, such as oil, gas, brine or water wells for the purpose of increasing their yield, particularly those in a mineral bearing stratum consisting of limestone or other calcareous formations.

The principal object of the invention is to counteract in some way effects which may have come about which have tended to decrease the yield or output of the wells. The patent points out in some cases the output may have decreased to such an extent that further operation has become unprofitable. The idea is to introduce into such wells a solution containing acid or consisting largely of an aqueous solution of hydrochloric acid, which will react with the formation, increasing the size of the openings or crevices.

The next point mentioned in the patent is that in carrying out the method an acid is employed, preferably hydrochloric acid, to which is added a small amount of a substance which is capable of inhibiting the attack of the acid

upon metal surfaces, such as upon surfaces of iron or steel. No mention is made at that point as to why that is desirable but it is pointed out that it is desirable. Mention is made as to inhibiting agents used, a preferable one being an arsenic compound soluble in the acid solution, such as arsenic acid, arsenic trioxide or soluble arsenate. It is pointed out, also, other inhibitors may be used, such as cyanides, organic nitrogen bases such as aniline, phenylhydrazine, pyridine, quinoline, acridine and derivatives thereof, organic sulphur compounds, such as mercaptans, as well as various by-products of industrial processes. Then the patent goes on to mention that the strength of the aqueous hydrochloric acid solution which is preferable is between 5 and 20%—I should say the preferable concentration really between 10 and 15%, although other concentrations may be used.

Then the author of the patent goes on to mention how the acid may be added. The acid solution is preferably added in an amount calculated to fill the bore of the well to a depth not exceeding the thickness of the mineral bearing stratum, and points out to force the charge of acid out of the pump tube into the bore of the well against the head of the oil standing in the well it may be necessary to introduce pressure to force out the acid by pressure or other suitable means, as by a pump. After the acid has reacted with calcareous material and has practically ceased, it is suggested that the spent solution may be removed from the well by pumping or by bailing out. An example is given of the practical use of the method in the Central Michigan oil fields. I don't know that it is necessary to go over the amounts of materials used. It is suggested that 15% hydrochloric acid solution might be used with 2 gallons of arsenic acid, 4500 pounds total of the acid, and 2 gallons of arsenic calculated as As_2O_5. It is suggested that this mixed solution can be charged into the oil well through the iron pipe tube; that this may be followed by a quantity of crude oil to force the acid out of the bottom of the tube into the well, and then after the acid has become exhausted may be

pumped out and thereupon regular pumping of the oil may be resumed. In the case mentioned in the application in the Michigan field, it was stated that the production of the well treated was approximately doubled with one treatment.

Then the patent further states the method has been used repeatedly for the treatment of low yield or exhausted oil wells in territories, with resulting increase in output resulting from 75 to 200%, and that in some cases that the wells which have ceased to flow have been brought back to the resumption of the natural flow.

On page 1, line 43, it is pointed out—"As an illustration, a chemical method is described in United States Patent 556,669, according to which the flow of an oil well in a limestone formation is increased by treating with a quantity of an acid, such as hydrochloric acid."

The Court: Well, now, what new do they claim? What improvement do they claim they made over that? How do they claim they change? A. My understanding is that the main claim for improvement is the addition to the hydrochloric acid of some material which will inhibit the action of the acid.

The Court: There is no claim that the acid, for instance, in this well, would not have done just as good a job as if it had not gone into it— A. I do not believe so.

The Court: They do not claim any new useful result. They just claim to have avoided a misfortune. A. The useful result would be limited apparently to the equipment, rather than to the well itself.

The Court: As far as increasing the flow of the well, and all of that, they do not claim to have accomplished anything? A. I don't think so.

The Court: But simply to have avoided a misfortune? A. I think so. Inhibitors, such as are suggested here, as far as I know, would have no effect on the acid, in connection with its reaction upon limestone.

The Court: All right. In other words, it has absolutely,—the adding of this has no effect that we know anything about or claim anything about on the work which

is desired to be done in treating the well? A. That is my understanding. But, it does have a specific function on the metal equipment used in connection with the well treatment.

By Mr. Owen:

Q. Would you say, Doctor, whether or not the presence of an inhibitor in the acid, which will prevent or restrict its reaction on the pipe and other well equipment, would have any bearing on the strength of the acid which goes into the formation? A. As I understand the question, the answer is "No." That is to say, the mere presence of the inhibitor in the acid would have no effect on the strength or work the acid would subsequently be able to do.

Q. Would an uninhibited acid which attacks the metal reach the formation in the full strength in which it was introduced into the well tubing? A. No, it would not. Some of the acid would be expended by reaction with the metal of the well tubing.

The Court: What fraction of one per cent do you think it would be diminished? Surely not more than one, not above; it would be a fraction of one per cent of your total acid as it went down into your well, wouldn't it? Don't you think it would be less than one per cent that would be diminished? A. Well, it would depend on the rate at which the acid were added and the amount added and the method of handling it in general. That would vary, of course, with treatments, depending on the amount of acid used in a specific treatment as well as the method in which it was used.

The Court: Which does it like better, iron or lime? A. It will react more rapidly, ordinarily, with lime.

By Mr. Owen:

Q. Have you tested and analyzed any samples of hydrochloric acid solutions for the Dow Chemical Company during the past two or three years, which you understood to have been some of the acid used by the defendant in this case, the Halliburton Oil Well Cementing Company, in treating wells in the Central Michigan fields? A. We have.

Mr. Owen: I will state for Your Honor's information that some of the depositions which were offered in this case and were not read dealt with the obtaining of the samples from the oil wells and sealing and delivery to the vault of The Dow Chemical Company, and then there were affidavits signed by the men who delivered those samples from the Dow Chemical vault to Dr. Bartell and Dr. Bartell's affidavit that he had received them, and it was stipulated that if those witnesses were called they would so testify.

Mr. Lyon: That is correct.

The Court: I am satisfied as to the identity of the samples.

Mr. Owen: It was just to trace the samples from the Halliburton tanks to the laboratory of Dr. Bartell.

The Court: I am satisfied with that proof.

By Mr. Owen:

Q. Who, if anyone, assisted you in making the analyses of these samples? A. Dr. Paul H. Cardwell.

(Dr. Cardwell was present and also was sworn as a witness.)

Q. What has been Dr. Cardwell's education and training? A. He received the Bachelor's degree at Central State Teacher's College in 1935. He entered the graduate school of the University of Michigan in 1936, received the Master's degree about a year later, and then served as assistant in the department, Teaching Fellow, and obtained his Doctor's degree in June of the present year, 1941. He has specialized in chemistry during all of his graduate work.

Q. It is in evidence that samples of acid taken from defendant's truck tanks during its acid treatments of the Stella Wilcox well on August 5, 1938, of the Zahn well on August 19, 1938, and of the Crawford well on September 10, 1938, all in Ogemaw County, Michigan, were delivered to you; the Stella Wilcox samples being numbered 5, 6 and 8, the Zahn samples being numbered 12 and 12-B, and the Crawford samples, two in number, being numbered 15. Will you state whether or not you received such samples? A. I did receive such samples, with the same numbers as mentioned.

Mr. Lyon: May it be understood that any testimony regarding these samples is subject to the objection heretofore made, without the necessity of further repeating that objection? That is the objection as to the fact that those wells were treated on the authority of and with the consent of the Dow Company.

The Court: Yes. I will overrule that objection, so you may have the benefit of having objected to the question, and I give you an exception to it all the way through.

By Mr. Owen:

Q. What, if any, instructions did you receive in connection with those samples? A. I was instructed to examine them, to determine whether they contained hydrochloric acid, and the approximate strength, if the acid proved to be hydrochloric acid, and to make corrosion studies to determine whether or not these samples of acid contained a material which served as an inhibitor, in so far as the corrosive effect against iron or steel was concerned. Each of these samples contained hydrochloric acid of approximately fifteen per cent concentration.

Mr. Lyon: I am not interested in that analysis. There is no question about the defendant using hydrochloric acid.

The Witness: We were requested to test the samples and determine their corrosive action on iron or steel, and naturally we expected to compare the action of these acids with acids which we knew to contain no inhibitor, and the test we were to make was for the purpose of determining whether or not these acids contained a substance which functioned as an inhibiting agent. And, so, to make the test that was requested to determine whether or not these samples contained material which functioned as an inhibiting agent, the thing we did was to obtain chemically pure hydrochloric acid, make up solutions of strength identical to that of each of the samples mentioned, and test them side by side, figuratively, to determine the corrosive action of the chemically pure acid in solution with that of the oil well sample solution and note their reactivity on the metal. Perhaps I should make a statement before starting in, which may save

me embarrassment later. Naturally, the amount of samples we had was limited; otherwise we could have made, perhaps, elaborate tests. But we had, as I recall, not over about a liter of each of the samples. A liter is in the neighborhood of a quart. So we had to regulate our set of experiments accordingly.

In setting up the experiments we decided to use about 50 c.c. for each test, since it would be desirable to run a number of duplicate samples. That would fill perhaps a two-ounce bottle. The acid was placed in small wide-mouthed bottles. They were about 3 inches in height and an inch and a quarter by an inch and a quarter in width. The metal pieces used for testing were rectangular pieces 1" x 7/8" by 1/8" thick. In the first series of tests which I will mention, these pieces were cut from strap iron. A small hole was drilled through the metal at one end near the middle or center so that the strip could be suspended in the liquid. The strip was suspended by means of a glass support so the acid would not react on it. In the first series of tests, the solutions were not agitated. The experiments were carried out at a temperature of 85 degrees Fahrenheit, and the time of the tests was 16 hours.

The Court: As I understand it, you had one of these containers with the acid that came from the defendants, and then one of acid that was not inhibited? A. That is right.

The Court: And you took the same length of time, and the experiments were made under identical conditions? A. Under identical conditions, treated in the same manner just as far as it was possible.

Mr. Lyon: There is just one bottle of defendant's acid in this, and one bottle of chemically pure acid, is that right? A. No, that represents a single test. Duplicates were always run of not less than five, or three at least, not less than three at least of each.

The metal strips were sawed from about an inch wide strap iron, and then were sand-blasted, for cleaning, and were not touched after the sand-blasting, that is, touched by hand, or in any way on the surface.

By Mr. Owen:

Q. You did not give the strength of the samples of defendant's acid, can you give that? A. I can. The strength of sample 8, as indicated on my notes, was 14.8 per cent, that is the sample for the Stella Wilcox, 14.8. Sample 6 Stella Wilcox, 14.8.

The Court: They were taken out of the same tank, as I understand it.

Mr. Owen: That is right.

A. Of course, there might have been a slight variation if the sample bottle was dipped into the tank at different points, or stirred up the material after dipping. I don't say there was any reason why the samples should analyze exactly the same.

Mr. Lyon: Do I understand, Mr. Owen, the plaintiff took one two-gallon sample or took two one-gallon samples?

Mr. Owen: Two one-gallon samples.

By Mr. Owen:

Q. What was the strength of the other samples? A. The sample indicated as 12-B was 14.5 per cent, and the sample indicated as 12 also 14.5 per cent. From the Crawford well, we had two different samples which happened to carry the same number, 15. They were obtained by us at slightly different times. They both were of 15.2 per cent concentration.

The Court: That comes out the way we would expect. There isn't exact uniformity between wells.

Mr. Owen: That is right.

The Court: But as to samples from the same wells, complete uniformity. It so happens, as you point out, we wouldn't be greatly disturbed or surprised if there had been a little difference, but there wasn't any. A. That is right, Your Honor.

The Court: They had them pretty well mixed, in other words.

Mr. Owen: The truck had traveled, I think, 60 or 70 or 80 miles, and they probably were pretty thoroughly mixed.

The Witness: By blank samples we refer to samples of the acid that we made up by using chemically pure acid with water, of the same acid strength as the particular tank sample. For the Stella Wilcox well we prepared but one blank, since all of the acid samples were of the same strength, namely, 14.8 per cent. That is true also of the Zahn well and the Crawford well. I have tabulated the results of our comparative corrosion tests made with the samples of defendant's treating acids and with these blanks which we prepared. I have such data in form indicated as table I.

Mr. Owen: I offer this table in evidence as Exhibit PX-154.

A. In this table I recorded the results obtained in corrosion tests, as described; namely, with metal strips of strap iron of approximately 1 inch by 7/8ths inch by 1/8th inch, with the solutions as indicated in the first column of the table. The experiments were all carried out at 85 degrees Fahrenheit, using 50 c.c. of the acid solutions. The tests were all carried for the same length of time, in this case 16 hours. The metals used are from two batches of strap iron, one marked Series B and the other Series D. It happened to be that those were from different pieces of strap iron. In the second column of the chart is represented the per cent of hydrochloric acid. In the third column is represented the initial weight of the metal strips. In the fourth column, the final weight, that is to say, the weight after the action of the acid upon the iron. In the fifth column is given the loss in weight. In the sixth column the per cent loss in weight. In the seventh column the calculated per cent reduction in corrosiveness. I will explain the meaning of that seventh column later.

As an example, in one series of tests with Sample 8, Stella Wilcox, a single experiment gave these data: The initial weight of the strip was 14.4300 grams. The weight after action of the acid indicated as final weight 14.1386. The loss in weight 0.2914 grams. Or the per cent loss in weight would be 2.02.

Now, the average values, obtained by three sets of tests as indicated, gave as an initial weight 14.4308 grams. The final weight 14.1415 grams. The loss in weight 0.2893 grams. The average per cent loss in weight 2.01. And it would be noted that the average per cent loss in weight was practically the same as the per cent loss in weight of the single sample first mentioned.

In the second series of tests, using blank acid of the same strength as Sample 8, and referred to as "Blank 8 C. P. HCl.," the average initial weight in grams of three samples was 14.4287. The final weight in grams average was 13.8816. The average loss in weight of the three samples 0.5471 grams. Or a per cent loss in weight of 3.79.

I think perhaps the simplest way to represent what is meant by per cent reduction in corrosiveness, and how the figure 47 in the last column was obtained, would be to represent it in this way: It will be noted that the average per cent loss in weight of Sample 8 was 2.01, and the average per cent loss in weight of the corresponding blank was 3.79. Now that represents the ratio of per cent loss in weight. Now if one lets the loss in weight obtained with the chemically pure acid be represented by 100 per cent, one then would have the ratio of 2.01 is to 3.79 as x is to 100, and the x would represent then the relative corrosiveness of the sample acid. Now, in that case x would represent and be equal to 53. Or 2.01 is to 3.79 as 53 is to 100.

The Court: Well, is the 47 per cent of 3.79? A. The corrosiveness would be as 53 is to 100. The reduction in corrosiveness then would be 100 minus 53 or 47. The 47 would represent the reduction in corrosiveness of the sample acid as against the CP acid. Or, suppose we were to represent that diagrammatically. If one were to represent the amount of corrosion of the C. P. acid by a straight line and let that line represent 100 per cent, the corrosiveness of the sample acid would end out here at 53 and the reduction in corrosiveness would be represented by the value 47. So setting it up in that way it is fair to state that the reduction in corrosiveness was 47 per cent. The amount

of corrosion would be dependent on the surface area, but it happens these small pieces were cut all to the same size and so had practically the same surface.

We followed the same procedure with respect to each one of those different samples as I have explained with respect to Sample No. 8. The sample indicated as 12-B from the Zahn well showed a reduction in corrosiveness over that of the CP acid of 48%. The corrosiveness was 52% that of the corrosiveness of the CP acid, or the reduction in corrosiveness was 48%. The Stella Wilcox sample No. 5 showed a reduction in corrosiveness over that of the CP acid of 42%. Stella Wilcox sample No. 6 showed a reduction in corrosiveness of 42%. The Zahn sample No. 12 showed a reduction in corrosiveness of 42%, and one of the Crawford samples No. 15 showed a reduction in corrosiveness of 69%, and the other one 71%. Approximately the same.

By Mr. Owen:

Q. Well, now, I understand that samples No. 8 and No. 5 and No. 6 came from the same well, the Stella Wilcox, and from the two-gallon sample of defendant's acid which was taken at that time. Will you explain, if you can, the difference in corrosiveness or reductions in corrosiveness which you have found for those different samples? A. Well, since the acid content of those samples is the same throughout, it must be that there is a slight variation in some other constituent present in the samples.

Q. Did you make any other tests with these same samples of defendant's acids and the corresponding blanks? A. Yes.

Mr. Lyon: I don't understand what the bottom figures are. Average 15 blank, and then there are 3 blank fifteens in there. What is the significance of those? A. Well, the average of 15, the figure indicated by that, would come over in the fifth column, which is 0.2454%. That means that the average of two samples 15 had a value of 0.2454% loss in weight.

Mr. Lyon: No. I was asking about 3 at the bottom,

Dr. Bartell. I don't understand what blanks those were that were added together under that title Blank 15 CP. Then there is another one and another one. What 3 blanks were those? A. Oh, those were simply separate tests with the same concentration of acid but using different pieces of metal. You see in the column 3, the initial weight in grams is slightly different, indicating that separate tests were made, 3 distinct tests with that particular sample of acid.

Mr. Lyon: Well, can you explain to us again why the per cent loss in weight on those 3 blanks average 5.73, while the blanks up in series D seem to be around 3 and 3.5; or thereabouts? A. Would this be a fair question as to why the per cent loss in weight shown by the blanks 15 are higher than the per cent loss of weight shown by the earlier blanks?

Mr. Lyon: Yes, that is why I am trying—(Witness interposing) Well, if you use the question, I think a fair answer would be that probably the two series of metals used were of slightly different composition and had different rates of corrosion.

Mr. Lyon: They weren't cut out of the same metal? A. No. Series D was cut out from one strip of strap iron; Series B another. So the iron differed slightly.

By Mr. Owen:

Q. Now, I asked you if you made any similar tests with these acids using other materials, and I believe you stated that you did. Will you refer to those tests, and if you have any table showing them, will you produce that table? A. We have made similar tests with other materials, with metal strips cut from oil well pipes. We obtained oil well pipe from the National Supply Company, from the Oil Well Supply Company, and from the Atha Supply Company. We have data corresponding to the data given for the experiments made with strap iron, for metal strips of approximately the same size as those used of the strap iron material, but cut from oil well pipe.

The metal pieces were approximately, in the case of

the National Supply Company pipe, one inch by 7/8ths by 3/16ths. The thickness of the pipe of the different companies was all practically the same, all practically 3/16ths, and the other dimensions were 1 by 7/8ths, the same. The same amount of solution, of the acid solution, was used as was used previously, namely, 50 c.c. The experiments were carried out at 85 degrees Fahrenheit, and the tests were again run for a period of 16 hours.

Mr. Owen: The table showing the results of those tests is offered as PX-155.

By Mr. Owen:

Q. Will you explain what this Exhibit PX-155 shows? A. That shows the results obtained in corrosion tests, using the National Supply Company pipe material, with the different acid samples. We followed the same procedure as we did with the strips of strap iron which I have already explained. We prepared blanks of C. P. acid, of strengths corresponding to each of the oil well samples, and carried out the experiments in exactly the same manner.

PX-155 relates only to the tests made with the National Supply Company pipe. I also have tables showing the results of our tests with the other two pipe samples. The results obtained with the Oil Well Supply Company pipe material are shown in Table III.

Mr. Owen: That will be offered in evidence as PX-156.

The Court: Let me see about PX-155. This differs from the other only in that you used different materials for the acid to eat on? A. That is right, Your Honor. That is the only difference between this and PX-154. The pieces of metal were essentially the same size, but different kind or quality. And the acids were the same, and we took the same length of time, 16 hours, but it was different metal, oil well tubing instead of strap iron.

The Court: I can't compare the results, can I, on account of the shape? Wasn't that different? A. The shape was practically the same except the thickness was just a little different, because the thickness of the pipe was a little different than the thickness of the strap iron. The pipe was

a little thicker. The strap iron was 1/8th of an inch thick, and the pipe about 3/16ths.

The Court: There wasn't as much difference in percentage? A. That is true.

The Court: And, how do I know but what that is all due to the difference in the shape? A. Well, I can very quickly, Your Honor, give you the relative ratios of those surfaces of the metals, if you wish, and they are so nearly the same that that would not quite account for the difference that occurs in the corrosiveness. The area, surface area as calculated for the surface of the strap iron strips was 14.58 square centimeters. For the National Supply Company pipe, 14.52 square centimeters. The area of the Oil Well Supply Company sample was 14.52 centimeters square, and the surface area of the remaining sample cut from the Atha pipe was 15.33 square centimeters. So, it will be noted there is not a great difference in the surface area altogether.

Mr. Lyon: Just so the record will be clear, Doctor, these samples on which these tests were made were immersed in the acid so that the metal strips or specimens were contacted with the acid on both sides of the metal, were they not? A. On all sides, yes. The area I am giving you represents the total area exposed on all sides.

Mr. Lyon: And were these other pieces of metal in Tables II and III, and similar tables, all sand-blasted before— A. (Interrupting): They were all treated in exactly the same way.

The activity of both the oil well sample acid, and the blank acid, the action was greater with the oil well pipe than with the strap iron.

Mr. Owen: Table IV, showing the results of tests with Atha Supply Company pipe is offered as PX-157.

By Mr. Owen:

Q. As I understand you, these results or these tests, the results of which are shown in your tables numbered I, II, III and IV, which are in evidence as PX-154, 155, 156 and 157, represent the results of similar tests with four different metals? A. That is right.

Q. And the only difference in the tests was in the metal used? A. Yes, so far as we could control the experiments.

Q. Are you able to give the average reduction in corrosiveness in the tests made with strap iron as between chemically pure acid and the several samples obtained from the defendant's treating tanks? A. Yes, I think so. With the strap iron the average percentage reduction in corrosiveness of Samples 5, 6 and 8 from the Stella Wilcox well, gave a value of 44 as per cent reduction in corrosiveness. The average reduction in corrosiveness of all seven samples shown in PX-154 is 52 per cent.

The Court: That is the average of the samples taken from the wells? A. That is right, Your Honor. The reduction in corrosiveness was obtained for each of the seven samples and the average of those values gives a figure of 52, which means that the average of the reduction in corrosiveness of the 7 samples is 52%.

The Court: You took the average of those because they differed too, the CP acid experiments? A. Oh, they did.

The Court: You took an average on those? A. Yes, Your Honor. In each case, the sample obtained from the well, the acid sample was tested against a CP acid sample of the same strength.

The Court: But the CP acid of the same strength differs? Take right down in your table I, where you take the first line, blank A, so and so, you come over there. A. Yes, the blanks, the concentration of the CP acids, were changed to fit the corresponding acid which they were tested against.

The Court: But the loss in weight is a little bit different on those two. I have .0142 difference in one. That isn't very much.

Mr. Lyon: Maybe we could ask this question. I don't think it is out of order, if the witness can tell us, so that we will know something about what order of accuracy these measurements are believed to have. Within what percents or what decimal point are these results reproducible, do you know? A. Well, I think the set of three tests would

come pretty close to giving us that answer. No two pieces of iron are going to be exactly the same, so that the results will not be identical, but in the first set of values, for example, with the sample 8, Stella Wilcox, the loss in weight of the very first sample was 0.2914 grams; of the second sample 0.2911 grams, which means in that case the two losses in weight checked to within three ten-thousandths of a gram, which is most surprising. But in the third series, the loss in weight was .2854, which is somewhat larger than the other two. So I think that that will indicate pretty well the type of variation to be expected with different samples of the same liquids, but with different samples of iron.

The Court: This question will probably show where I have missed something, or my ignorance, or something. I want you to show this so you can set me right. Now I am looking at Table I, Series D. Then take the very first line, sample 8 Stella Wilcox. Now, that is followed by 3 there, and as I understand it, so far as you know, those three samples are out of the very same liquid. You only ran it to check your test, for safety in your test rather than to find out whether it was different, because you started in with the knowledge that those samples of acid were exactly alike, as I understand. A. As a matter of fact, Your Honor, we took out of the same bottle the material which we diluted and we used identical solution for the three different tests.

The Court: As I understand the running of those three tests was to avoid making a mistake, and they did come out near enough alike so you were satisfied you hadn't made a mistake, isn't that the right theory? A. Yes.

The Court: In other words, the only thing there was that could be any different was in the iron, and probably in cutting out the iron there would be a little difference there? A. Well, yes, Your Honor, but not a difference in size, but probably the composition of the two pieces of iron.

The Court: Even though they were cut out of the same strip? A. Even though they were cut out of the same strip there would be some little difference.

The Court: I say, if there is any difference, it was not in the acid, but it was in the sample that you were treating, is that right? A. That is right.

The Court: The same thing applies when we come down to the blanks that you have? A. That is right.

Q. Your acid was just alike? A. Exactly the same.

Q. As I say, you got three pieces of iron as nearly alike as you could get them? A. That is right.

Q. But any difference there was there in that result probably comes from a difference in the iron, is that right? A. That is right.

The Court: Now do I understand you to say that you have compared for certain figures, taking the initial weight and the final weight, and loss in weight, and percentage of loss in weight and so forth—do I understand that you have compared a certain one in that first group with a certain one in the second group? A. No, Your Honor. We have taken the average of all three in the first group and compared them with the average of the second group.

The Court: You made no comparison of each one? A. No comparison of each one. We simply compared the average of those in the first group with those in the second group.

The Court: Because there was no reason for picking out the first one here and the first one there and comparing them, is that right? A. No, there would be no point in picking those out and comparing them in that way.

The Court: All right. I have followed you.

By Mr. Owen:

Q. Turning now to PX-155, which is your Table II, can you state the average reduction in corrosiveness of all of the tests shown on that sheet, comparing the tests of the defendant's acids with those of the C. P. acid? A. Calculating the per cent reduction in corrosiveness for each of the sets of defendant's acid against the blank and then taking the average of each of those values gives us for the seven samples an average value of 30 per cent. And table III, by similar calculation, gives an average for the seven

samples of 38 per cent. Table IV shows for similar calculations a value of 48 per cent. Now, if you want to go further than that and take an average of all those averages you have a value of 42 per cent.

The Court: What do you do, just add them together and divide by 4? A. That is right, Your Honor.

The Court: Have you got the same number of experiments on each sheet? A. Just about.

The Court: If you haven't, you wouldn't be just right to do it that way? A. No.

By Mr. Owen:

Q. Doctor, I had on my preliminary chart a figure of 49 per cent for the average reduction in corrosiveness in connection with your Table IV and you gave it as 48 per cent. I have just had Mr. Cardwell check it, and he informs me that 49 per cent is correct. Would you mind checking it to be sure? A. I am not surprised, because I made a hurried check of that in pencil a short time ago.

The Court: What would you do, add them together and divide by 10?

Mr. Owen: Yes.

The Court: We ought to be able to do that all right. We might make a mistake about the other. A. Well, the difference is apparently that I took an average of seven samples, and perhaps the average just calculated was for the ten samples.

Mr. Allen Owen: While there are ten figures appearing in this last column, Your Honor, the 4th, 7th and 10th figures are averages of the ones immediately above them, so it would not be fair to add all of them. You should add figures Nos. 1, 2, 3, 4, 6, 8 and 9 and divide by 7 in order to get the proper average percentage reduction in corrosiveness.

The Court: I think we will all agree to that.

The Court: And you have got to treat averages with great care. We will suppose that we average the percentage of colored people in Bay City with the percentage of colored people in Detroit, add the two together and di-

vide by two. You get a very bad result. One is so great that Bay City doesn't cut much figure, yet you are giving it an equal ranking. Maybe that does not enter in here, but I am suspicious that it does somewhere. Do you still stick to your figures? A. Well, Your Honor, I perhaps was inclined to leave the number low and not use the highest figure possible. It is between 48 and 49. It is a little closer to 49 than 48, so perhaps we should call it 49. I think we would be justified in calling it 49.

The Court: Does that mean in English and in figures that this that the Dow was using on that first group right there, we will say the amount of corrosiveness was 47 per cent of what the acid without any inhibitor would be? A. Yes, Your Honor. Or referring to the graph on the chart the C. P. acid gave a certain corrosiveness.

The Court: Well, but which is the amount it ate up? A. The amount it ate up, yes, Your Honor. And with the acid sample referred to, Sample 8, the corrosiveness was really 53 per cent of that of the C.P. acid. Or the reduction in corrosiveness over the C.P. acid was this value of 47 per cent.

The Court: Well, is this your contention as a result of that, that no matter what the shape is, no matter what the size is, if you use those two kinds of acids, this kind which the defendant uses will eat 47 per cent as much as the pure acid? A. Not 47 per cent as much. It will eat 47 per cent less of the iron than will the C.P. acid.

The Court: It reduces it 47. A. That is right.

The Court: To put it the other way, it will eat 53 per cent as much. A. Yes, Your Honor, with that particular iron.

The Court: No matter what the shape is? No matter what the weight is? But it has got to be left sixteen hours. A. I believe that to be true. Provided the ratio of the surface area to the amount of solution were the same.

The Court: I want it to happen the same in each case, that is, exactly the same size, of this kind of iron that you have, exactly that kind of iron, but I thought if you were

right in your argument, that no matter what the shape was, no matter what the quantity was, that if you put the same quantity and the same kind into each, the same shape in each, and left them there for 16 hours, of this kind of iron, mind you, that it was your conclusion that the defedant's acid would eat 53 times as much as the pure acid? A. Your Honor, unfortunately that does not happen to be quite the fact, as we have discovered.

The Court: I thought you were claiming that much for it. Now, you do not claim that much for it? A. I cannot claim quite that much for it.

The Court: Well, all right. What is it that you do not claim to be the fact? A. I must face this fact, that by altering the area exposed as compared to the volume of the acid medium, that that fact, the relation of the area to the volume of acid medium will make a difference. That is difficult to see why at this point, but we will have to face that fact.

The Court: A different iron might make a difference? A. Yes.

The Court: But here you have got two different kinds of strength? A. Yes.

The Court: Say, two men of different strength, one might be able to do a lot more than the other one could do, one might take quite a lot on, and the other take a little, but we can figure out their percentages as to their strength; on other kinds of work you can figure out very accurately the percentage of strength? A. Yes.

The Court: I knew that you did not make any claim that with different kinds of iron your result would be uniform? A. I have found, Your Honor, that I cannot even make the claim that you suggest, at first I thought I might be able to.

The Court: I am glad to know it, because I thought— A. And that will come out later.

The Court: Then what good do these percentages? What do they prove? A. They will show, with the experiment run under these conditions, that the C. P. acid is

more active than the sample acids. Now, if I had been fortunate enough, or wise enough to have selected different conditions in the first part of my experiments, I might have obtained results that would have been even more outstanding. I feel that the results that I am presenting to you at this time represent about the minimum of differences as it has worked out, but I did not know it when I ran these experiments.

The Court: Does whether it was under pressure or not make any difference? A. It might make some difference.

Mr. Lyon: What about temperature? A. It might make some difference.

Mr. Lyon: It does, doesn't it? A. I would expect it to. Some difference.

The Court: You mean the ratio would be different? A. Possibly. Yes, the difference in the ratio would be different.

The Court: There are some things we know. We have different kinds of iron in these two here and you have proven with a different kind of iron the ratio between the two acids varies. A. It varies, yes, it does. But in every case tested with all these different samples, the acid well samples showed less reactivity than the samples of the CP acid. That much we certainly have shown.

The Court: Then all this simply has to do with inhibition? A. Inhibition, yes.

By Mr. Owen:

Q. It is in evidence that there were delivered to you samples of hydrochloric acid taken from the wooden storage tanks of the Halliburton Oil Well Cementing Company at Mt. Pleasant. Those samples were marked N14-B, S14-B, N17-B, S17-B. Do you recall having received those samples? A. Yes, we received those samples, and I might mention that in all our records the samples marked N17-B and S17-B will be referred to as S20-B and N20-B. When the samples were delivered, as I recall, I was requested by Mr. Conner to use that notation and for the moment I don't recall why.

Mr. Owen: That explanation is in the depositions that have been filed, Your Honor. Mr. Conner explained that when this sample was taken, the N17B and the S17B—that means the North and South storage tanks of the Halliburton Company at Mt. Pleasant—he marked them with the 17 N and S series, and when he later examined his list of samples he found that he already had a 17. So he requested Dr. Bartell to change the markings on these samples to N20B and S20B, but Dr. Bartell states that he did not change them on the samples themselves but that in referring to them in his testimony he will use the 20 figure instead of the 17.

Mr. Lyon: Before we start in with any tests on commercial acid, I want to raise a question regarding the proofs, because tests on commercial acid, as compared with the well acid, would not have any significance here. It would be necessary that the well acid and the commercial acid correspond to each other; in other words, that the well acid be that commercial acid after it has been in the tank and been acted on by the lead plate and the current.

We are not satisfied with the proof in this case, and want to raise an objection, that the commercial acid that they are relying on here is the commercial acid that was used in wells on which they have the samples from the well acid.

I would like to call Your Honor's attention to this fact, that the Stella Wilcox well, which the witness has samples of well acid, was treated on August 5, 1938; the Zahn well was treated on August 19, 1938; and the Crawford well was treated on September 10, 1938, as shown by the records, PX-18.

The testimony as to when the sample of commercial acid was taken from the storage tanks in Mt. Pleasant is in the depositions which were received here, but not read. The samples were taken by two of the plaintiff's employees, and the first one is a Mr. Forsman, who in his deposition states the samples were taken on the 18th of August and he says on page 113, "We immediately identified the sam-

ples as to which tank they were obtained from, and they were delivered to the Dow Chemical Company at Midland, Michigan, to Don Conner."

The other witness who assisted in taking the samples was the witness Day, who testifies at page 106 of his deposition as follows: "Q. Well, is it your testimony whatever samples you took from these tanks you brought over here, delivered them to me, Mr. Conner? A. Yes, sir."

"Q. When you delivered these samples over to Midland to Mr. Conner, was Warner Forsman with you or not? A. Yes, sir, both times."

Mr. Conner: If Your Honor please, that refers to samples taken on two different occasions, August 18th and December 6th.

Mr. Lyon: And Mr. Conner on page 134 of his deposition states:

"I requested of Mr. Day and Mr. Forsman some time in August, they obtain samples from the wooden storage tanks of Halliburton which I was told had acid in them, located on North Franklin Street in Mt. Pleasant, Michigan, on August 18th. I marked that date very clearly because it was the day before the Zahn well was treated, I think. On August 19th Day and Forsman brought to me in the Midland office of the Dow Chemical Company, two bottles containing a liquid which they said was hydrochloric acid, each bottle had attached to it a sticker."

Mr. Conner, as I understand it, admits he was in error on that, because Mr. Babcock has showed him that he was in Oklahoma taking depositions at that time, and there is some mistake here, but the samples were taken some time by the light of the moon, and the Halliburton Company has no way of checking. But, obviously, it seems to me they were not the samples of the acid which was taken out of those tanks and taken out to the wells and used in the treatment of the wells, and it would become very significant in this case, I think, whether there is any,—in connection with any comparisons of the condition of the acid at the well and as it was in the storage tanks, whether we are comparing

the right acids, and there seems to be some difficulty here, at least one of these wells treated on August 5th, and obviously that is a different acid from the one they are supposed to have obtained samples of the commercial acid, and another one on September 10th, which is obviously a different one, and the only one could be August 19th, and as to that, why, there is this discrepancy in the testimony, which, I think, needs some explanation before we accept it and go into a lot of proofs as to an exact comparison here which they are going to base an argument. If the samples are not correct, why, we shouldn't start with those proofs.

Mr. Owen: In answer to the statement made by counsel, I will say that there was a discrepancy in the testimony regarding the date at which one of these storage samples was delivered to the Dow Chemical Company and as to the person to whom it was delivered. Altogether, I think Mr. Conner or the witnesses secured some 12 or 15 samples and most of them were delivered to Mr. Conner, at least a good many of them were, and when he testified regarding the delivery of this particular sample he was in error and he admitted it later, and if there is any doubt about the genuineness of these samples, we will clear it up, Your Honor.

The Court: Well, I will treat that as an objection so you can save your record, and I will overrule it. That gives you your exception. But I will hear this proof. I will see. Have you made any experiment with the commercial hydrocloric acid? A. We have, Your Honor.

The Court: So you have got those figures, too? A. Yes, we have.

The Court: Well, wouldn't that help some?

Mr. Lyon: Well, the trouble is, if they are going to compare it with the acid at the well, it should be the commercial acid that was taken out to the well.

The Court: Well, this won't harm us.

Mr. Lyon: It won't hurt us.

The Court: But they say they have got the commercial acid, now.

Mr. Lyon: Well, commercial acid differs, lots of hydrochloric acid differs, as we expect to show, as much as any figures that they are relying on in this case.

The Court: Well, I noticed that the differences weren't an awful lot here, but chemistry deals with pretty small things.

Mr. Owen: I am satisfied we can meet that criticism, Your Honor.

By Mr. Owen:

Q. When you gave the average of reduction in corrosiveness of all of the defendant's acids on your Tables I, II, III and IV (PX-154 to 157), objection was made that they were averages of averages, and without asking you to do it now, I will ask you to make up a new average and be prepared to state what that is tomorrow, basing your average on each individual test and eliminating the averages which are shown in the last column of your several tables.

Q. Now, referring to the samples of defendant's storage acid which were marked N14B, S14B, N17B and S17B, which you received, it being understood that you will use the number N20B and S20B instead of N17B and S17B, will you state whether you made corrosion tests of those storage samples? A. We did make corrosion tests with those storage samples.

The witness produced two tables marked VII and VIII which were offered and received as PX-158 and PX-159.

The Witness: Table PX-158 shows the results of tests with metal strips of strap iron of the same size as used in the first experiments previously described with solutions which were not agitated, and the experiments were carried out at a temperature of 85 degrees Fahrenheit as the previous ones, the volume of the acid solution used being 50 c.c. The time of the test was 16 hours. In other words, all factors relating to the test were essentially the same as in the previous experiments, other than that of the acid samples used. The acid samples referred to as N14B, S14B, N20B and S20B were found to be of concentrated hydrochloric acid of approximately thirty per cent concentration.

The Court: Well, now what about the Wilcox? I have three on that. Now, Table II is the same?

Mr. Owen: Yes, Your Honor. That information applies to all exhibits.

The Court: And Table III is the same?

Mr. Owen (Interposing): As Table IV.

The Court: And so are II and IV?

Mr. Owen: Yes.

The Court: Where do I get that first sample N14B? Where was that from?

Mr. Owen: That was from the North storage tank of the defendant at Mt. Pleasant, and it was taken on August 18, 1938.

The Court: The day before the sample was taken from the Zahn well.

Mr. Lyon: That is the date I raise my objection to. Witnesses say they gave this sample to Mr. Conner while he was here. On that date Mr. Conner was taking depositions in Oklahoma.

The Court: When did you get this sample S14B?

Mr. Owen: Same as N14B, same dates and facts apply. The N stands for the North Storage tank, and the S for the South Storage tank. They have two wooden storage tanks at Mt. Pleasant.

By Mr. Owen:

Q. Now, will you explain what the data on PX-158 represents? A. I might mention that the acid samples from the storage tanks were of slightly different concentrations. The N14B originally as received was 28.5 hydrochloric acid; and the concentration of the sample labeled S14B was 29.3% hydrochloric acid; N20B was 30.3% and S20B 30.7%. I mention that to show that the acids were of slightly different strengths.

The Court: I don't understand why you didn't use them just as you found them. A. Had I done that, the strength would not have been comparable at all to the strength of the acid received as truck sample acid, which was about 15%, about half this strength.

The Court: That storage tank, in there it is not ready for use then? A. No.

The Court: It is going to be diluted or changed by them? A. It apparently does have to be, yes.

The Court: You changed it to get it as near as you could to the way you thought they would use it? A. Yes, I changed it.

The Court: You are showing there wasn't any inhibitor in this?

Mr. Owen: Very little.

The Court: Let me ask you, Doctor, there is a difference between this chemically pure and commercial hydrochloric? A. There is some difference, yes.

The Court: Is there some, in this commercial is there some inhibitant in that? A. There are materials that inhibit slightly.

The Court: The way they sell it? A. The way they sell it, that is true.

The Court: Do you claim they have a patent so nobody can buy any more hydrochloric acid?

Mr. Owen: Oh, no, we don't complain of their using it in the strength in which they purchase it, and with the inhibiting power that it has.

The Court: All right.

The Witness: This storage tank acid of the strength mentioned was diluted to 14.5 per cent, which was the strength of the acid samples 12 and 12B taken from the Zahn well.

Mr. Lyon: May I ask if the dilutions that are referred to on these tables PX-158 and 159 consisted of nothing but the addition of water to the commercial,—or to the so-called commercial acid taken from the storage tanks? A. That is right. Nothing else was put in except pure water, and a blank of C.P. acid of the same strength was prepared,—"C.P." meaning "chemically pure." For example N14B the initial weight of the metal strip used was 14.5279 grams. The final weight was 14.0619 grams,—loss in weight 0.660 grams, per cent loss 3.21. And, for the same S14B diluted

the same way, the per cent loss in weight of its metal strip was 3.29. For the corresponding tests made with the chemically pure acid of the same strength the per cent loss in weight was 3.46, which means that the sample N14B was 92.8 per cent as corrosive as the C.P. acid, or the reduction in corrosiveness was 7.2 per cent; while the sample S14B showed a corrosiveness which was 95 per cent as great as that of the C. P. acid—95.1 per cent, as a matter of fact, and the reduction in corrosiveness was 4.9 per cent.

The other samples N20B and S20B were diluted to an acid strength of approximately 15 per cent. It happened to be 15.1, which is the per cent concentration of many of the solutions we have used for comparison. The per cent loss in weight of the sample tested with the N20B diluted solution was 3.23 per cent, and the loss in weight of the metal sample treated with S20B was 3.36 per cent, and that of the sample treated with the blank of the same strength as the N20B and S20B was 3.64 per cent, which means that the reduction in corrosiveness of the sample N20B was 11.3 per cent; it was 88.7 per cent as corrosive as the C.P. acid, or showed a reduction in corrosiveness of 11.3 per cent. And the sample S20B showed a corrosive effect 92.3 per cent that of the C.P. acid or showed a reduction in corrosiveness of 7.7 per cent.

Mr. Lyon: Is that the same blank that you have at that point in PX-158? A. It would be the same kind of acid, yes.

Mr. Lyon: I call your attention to the fact that there are three values in per cent loss in weight for that blank, and—on both PX-154 and 158 and the individual values are identically the same, as well as the averages. Doesn't that indicate that they are the same? A. If that is true. Well, in other words, it was the same test. I, hurriedly in looking at these figures, did not happen to catch the corresponding values. The blank 14.5—(after examining documents); Yes, they were the same test.

The Witness: The blank of diluted N14B and S14B, using the C.P. HCl in PX-158 means that I took C.P. hydro-

chloric acid and diluted it to the 14.5 strength, and it so happened that I had already prepared such a blank which appears on PX-154 in the fourth series of tests, which read "Blank 12-B (C. P. HCl)," and I used that blank and the tests with that blank in computing or making up the table PX-158. The same blank acid was used in testing against Sample 12B as was used in testing against Sample N14B and S14B, and the solutions were all made up to the same acid strength.

The Court: Doctor, let me call this observation to your attention and see whether I am correct in my interpretation, and, if I am, whether it means anything at all. As I interpret your figures in PX-158, by looking at your loss in weight in grams column and then over cross-wise I am going to compare sample S14B diluted to 14.5 with the second one in the blanks, which is the blank diluted—I don't know if I do understand. I understood your blank to be your chemically pure hydrochloric acid. A. That is right, Your Honor.

The Court: Well, it doesn't matter which one I take, and I am taking the one to make the most trouble for you, which is the second one there. A. All right.

The Court: Now, that is diluted to the same 14.5. Now, I compare over in this loss in weight, in grams, the two, and I gather there that the only difference is .0091. A. Yes; that is correct.

The Court: Well, that is mighty little, isn't it? A. It is.

The Court: Now, I go right down to the 4th and 5th in the column, which are supposed to be identically alike, as near as we can get them, and I find a difference of .0512. In other words, I have got more than five times as much difference between your blank samples tested as I have got between one of the defendant's tests and your blank. A. Yes, sir, Your Honor, but this—

The Court: Suppose I was looking here to find out how much this defendant's dope was inhibited, and to determine that it would be perfectly fair, wouldn't it, for one

comparison, to go over to column 5, the loss in weight in grams, and take the second figure in that column and compare it with the fourth. Why wouldn't that be fair to see how much they had inhibited it?

Mr. Owen: Well, I think that in tests of this kind, Your Honor, it is impossible to have them exactly accurate, and that is the reason, there is a necessary variation.

The Court: But I say, if I was going to only run one test on each, that might be the one that would have been run.

Mr. Owen: Yes.

The Court: I understand you ran more for the purpose of getting the average.

Mr. Owen: Surely.

The Court: And checking yourself. But I am taking only one of those, and I am taking the lowest one and their highest one for the purpose, as I said, to trouble the doctor and make it just as tough as I could for him, you see.

Mr. Owen: If we had done that, we could have made a much better picture.

The Court: Yes, you could have. But I am taking the worst picture you can. I mean, maybe I studied it longer, I suppose, but there is one comparison, that all they would have inhibited it would have been .0091 grams.

The Court: In other words, if you had found the difference between Dow's and yours—

Witness (interrupting): Your Honor, may I remark that I don't believe the contention is that inhibitor has been put in this acid; that if they do not check, why it is just because there happens to be something in the acid that would cause them to be that different.

The Court: If you carried out into your seventh column (of PX-158) the difference between the fourth set of figures and the fifth, what will you get to put in the seventh column? 3.38, one is base, and one is something else—3.60, and what do we get for the seventh column?

(Witness made calculations, slide rule and mathematical)

A. For that particular combination requested and double checked, that would be about 6.1%.

The Court: Well, now, in other words, that means that if we were making this test and the one in the fourth place has been the defendant's, it isn't—it's one of your blanks, chemically pure—but if that had been one of the defendant's and the one in the fifth place had been run just as it was, we could argue from it that there was 6.1%—six and one-tenth per cent inhibitor in it. A. It could be argued that way.

The Court: That shows the argument that could be made and how careful we have to be here. We know there wasn't any inhibitor in it. We know your two acids were just alike. A. That shows why we have to run a number of tests.

The Court: And I don't know how many we would have to run. We are satisfied those two are absolutely chemically pure, each of them 14.5% hydrochloric acid, and we run them, and there is 6.1% difference in their corrosive action. Now, there isn't, as a matter of fact, any difference at all. A. Shouldn't be.

The Court: And the difference all comes by the difference in that iron in some way. A. That is true.

The Witness: I have pointed out that based upon the tests in PX-158 the sample N14B showed a reduction in corrosiveness of 7.2 per cent; S14B of 4.19 per cent; N20B of 11.3 per cent, and S20B, of 7.7 per cent.

PX-159 shows essentially the same type of results for the same type of tests as are shown in PX-158, the difference being that instead of using the strap iron as the iron pieces, strips were cut from National Supply Company's pipe of the size indicated, 1 by 7/8ths by 3/16ths, and the experiments were run exactly as were the experiments with the strap iron. For acid in these tests we had the samples N14B, S14B, N20B and S20B, which we have just discussed, together with the blanks corresponding to these diluted acid samples. In other words, the concentrations of the acids were exactly the same as the concentrations used in PX-158.

This is the National Supply pipe, and that is shown on Table II, PX-155. Referring to Sample 12B of Table II, the strength of the acid used there was 14.5, the same as we used in the tests for Table VIII.

The Court: But, over in Table II you had 14.8. Then you got down to the bottom and it says 15.1, and 15.2. You had a stronger solution of acid in Table II than you did in Table VIII. A. In some instances we did, slightly stronger acid, because the strength of the acid in the truck samples was a little greater for the samples taken from Stella Wilcox than from the Zahn well.

Mr. Owen: I think, Your Honor, you are overlooking the fact that the strength of the blanks was the same as the strength of the defendant's samples which were tested, so that those are the two that are compared in this Table II. You see where the strength of the Crawford acid was 15.2, the strength of the blank was also 15.2.

The Court: But, why was the loss in weight? When I am talking about loss in weight by defendant's acid and the loss in weight by chemically pure acid, I am not comparing one with the other. I was here considering loss in weight one with the other. Now, the size would have something to do with that? A. The loss in weight is not great; the sample N14B, 2.34 per cent, while with the blank, 2.53 per cent.

Mr. Owen: I think if Your Honor will keep this in mind it may help to understand these tables, that in every instance the comparison is made between a C. P. blank of the same strength as the defendant's acid which is being compared with it, so that you cannot say that that is not a fair comparison.

The Court: Do they say they have any of this lead metal electrical current in the storage tank?

Mr. Owen: No. That is a wooden tank.

By Mr. Owen:

Q. Now, did you also compare the storage, the defendant's storage tank samples, Nos. 14 and 20, with samples of commercial hydrochloric acids to see how their

corrosiveness compared? A. We did. We obtained commercial acids by purchasing directly from the different companies, ourselves. Lots of acid from the Detroit Chemical Works, from DuPont, from the General Chemical Company, from the Pennsylvania Salt Manufacturing Company, and from the Southern Acid & Sulphur Company.

Q. Have you prepared a table showing the results of those tests? A. I have for my own notes. I have no other table prepared. The tests were made with each of these acids diluted to a strength of 15.1 per cent hydrochloric acid. The metal used was from strap iron of the same lot as Series A previously referred to. Tests were made in vessels of the same size and the same size strips were suspended in 50 c.c. of acid as before, for sixteen hours at 85 degrees Fahrenheit, and in containers of the same size and shape. And the results obtained expressed in the same units that I have been expressing the other values in terms of reduction in corrosiveness.

The Court: You have got the other figures that lead up to those, so that if they want to see them they can, I suppose. A. I can get any other figures leading up to those, yes. I have them with me in town.

For strap iron, first, I will give the results with Detroit Chemical Works acid. That acid compared to the same strength of C. P. hydrochloric acid showed a reduction in corrosiveness of 15.0 per cent compared with C. P. acid. The DuPont acid with the strap iron, 3.7 per cent. The acid from the General Chemical Company 1.6; The Pennsylvania Salt Manufacturing Company, 0.5 and the Southern Acid & Sulphur Company acid 0.3. In other words, that showed practically the reactivity of the same order of magnitude as the C. P. acids. Now, the average reduction in corrosiveness, taking the average of those five values, would be 4.2, or the average corrosiveness was approximately 96 per cent that of the C. P. acid.

The Court: Well, there you go. As between the Detroit Chemical Works and Southern Acid & Sulphur Company, The Detroit Chemical has got fifty times as much as

the other of that inhibitor in it. A. It has relatively that much more inhibiting action, that is true.

The Court: And if anybody could step up from the other fifty times, they would have too much. Like the fellow who was asked if his brother-in-law was fifty per cent dependent on him, and he says a hundred and ten per cent. A. I have corresponding results with other metal strips, if they are wished.

The Court: That would be interesting. Now, this is all in the strap iron where we have such wide variances, except in the acid? A. Yes.

By Mr. Owen: You might as well give them, then, while you are on the subject? A. I thought it might be of interest to compare these results with those of the National Supply Company material, since we have already done that with the other series of acids. Using the small metal strips, of the same size as I have previously described, and using the National Supply Company pipe and the same acids as used with the strap iron tests, diluted to 15.1 per cent,—

The Court: Oh, you go right on down through, only with another kind of iron? A. With another kind of iron,—

The Court: What is the next kind of iron? A. The National Supply Company's pipe. I am taking the acids in the same order. The Detroit Chemical Works acid, a value of 12.2. DuPont, a value of 6.1. General Chemical Company, 5.4. Pennsylvania Salt Manufacturing Company, 0.7. Southern Acid and Sulphur Company, 0.7. The average of those values is 5.0.

The Court: Here is what surprises me now. The strap iron, the only difference between the strap iron and the National Supply Company pipe, when you use the Detroit Chemical, is just a difference of between 15 and 12.2, which is only 20 per cent.

Mr. Lyon: But it goes down.

The Court: And I come on down here to the next one, and I use the National Supply Company iron with DuPont, and here I get twice as much as I do when I use the other.

I just cannot get it through my head. It does not seem to work. A. Of course, in the latter case it is twice as much, the matter of three units only, 3 per cent out of 100 per cent.

The Court: In one it is twice as much, when I use the National Supply I get twice as much depletion with that one kind of acid, and with the Detroit I get 80 per cent as much. A. That is true.

The Court: I would think at least they would run the same way. A. It leaves considerable room for speculation. It just might be, of course, the inhibitor in the two cases are not the same, and it doesn't function in exactly the same way with the two types of iron. That would be one possible explanation. The impurities in the acid may be different.

The Court: But I don't get much satisfaction in taking an average on a thing that works that way. A. The average in that case is probably not as significant as the other type of averages we have taken of the average of a series of tests. That is significant. Here we have involved another factor—the fact that the composition of these acids, so far as impurities are concerned, are unknown to us. They may not be the same.

The Court: Well, let's get some more irons in here and see where we come out. You have some more. How many have you got there? A. Two.

The Court: All right. I think I will go for them. A. And they leave greater room for speculation.

The Court: And what are the other two? A. The third iron is from the Oil Well Supply Company's pipe and the fourth one from the Atha Supply Company's pipe. Oil Well Supply Company's pipe with the Detroit Chemical Works acid, the first one mentioned previously, 1.3; DuPont 3.5; General Chemical Company 0.2; Pennsylvania Salt Manufacturing Company 0.6; Southern Acid and Sulphur Company 0.2. Those results admittedly are quite different from the other results. With the Atha, Detroit Chemical Works acid 18.4; DuPont 12.0; General Chemical

Company 9.1; Pennsylvania Salt Manufacturing Company 3.5; Southern Acid and Sulphur Company, 9.4, showing distinctly that the different metals react quite differently with the constituents of the different acids.

The Court: I thought I could get down to the bottom there. When you came to the last one it jumps up 9.4. A. We simply took them as we found them.

The Court: If you could work something out of that—

Mr. Owen: I think Your Honor will find that these reductions in corrosiveness with these commercial acids with the exception of this one Detroit sample (and what is in that sample we don't know) but with that exception the reduction in corrosiveness as compared with the chemically pure acids seemed to run along in what the scientists call the same order of magnitude. They are not exactly the same but none of them is high enough to be any great amount of help in an oil well tubing.

Mr. Lyon: I understand that the plaintiff wouldn't charge infringement if any of these acids that have been referred to by the witness were employed as regular commercial hydrochloric acid with no addition of any other inhibitor. That is, DuPont acid or any of the ones the witness has referred to, is that correct?

Mr. Owen: I wouldn't say that, no.

The Court: You depend an awful lot on what you made your fight on.

Mr. Lyon: A fellow would have a hard time knowing on what he infringed.

Mr. Owen: I would say in answer to the inquiry that if the defendant or any other company which is acidizing oil wells for the purpose of increasing their production learned of a certain acid which contained impurities which were of a high order of magnitude and he selected that acid specifically for the purpose of getting the benefit of the Grebe-Sanford invention, I would say he probably would be held, or should be held, as an infringer.

Mr. Lyon: But if he did the same thing, used the same acid, he wouldn't be an infringer?

Mr. Owen: Well, that is a moot question. I don't think it is involved here, and I don't think I am required to speculate on what we might do under those conditions, but what we are complaining about here is something that this defendant has done deliberately.

The Court: Well, it would take 47 times difference if they were going to use,—what is that, Southern, is that, acid? A. Southern Acid & Sulphur Company.

The Court: If they are going to use Southern Acid & Sulphur Company acid it would take 47 times difference whether you bought your pipe of the oil WXC, whatever that is,—if one digs into it, you have .2, and the other 9.4. If I am right 1/47 times as much as the other. So, there is as much as you got in your figures difference than the kind of pipe they used with regular commercial acid.

Mr. Owen: That is true.

The Court: That is as much inhibition as you are suing them for.

Mr. Conner: No, it is not.

The Court: 47. That is what you claim here, 47.

Mr. Owen: No. We are showing that they are doing something to their acid that substantially increases its inhibitive power.

The Court: 47 per cent.

Mr. Owen: No. We don't say that they add 47 per cent of inhibition or of inhibitor to their acid, but we say that when their acids are delivered at the oil well and are used to acidize that well, that they are substantially inhibited within the scope of the Grebe-Sanford patent, and that that inhibition is due to something which they have done deliberately, and which has occurred between the time they placed their acid in their truck tanks and the time they delivered it from the truck tanks into the well.

Now, the question for Your Honor to determine ultimately is whether the amount of inhibition which they have deliberately and intentionally placed in that acid constitutes an infringement of this patent.

The Court: Well, of course, no matter whether they

put it in intentionally or whether they intentionally bought some already in, now that I find this out about this, I would go and buy some of this pipe made by the Southern—no, acid made by this,—I can take the combination in there and get something pretty good, or buy the right kind of acid and right kind of pipes to put in there and I would be pretty well fixed.

Mr. Allen Owen: You would still have a reduction in corrosiveness.

The Court: Of course, I haven't found out yet about that in the pipe, how bad it is and how much I would need, but I think when I get through and get that information it will help.

Mr. Wilber Owen: You could not select your pipe in which you are going to put your acid, that is sure. You might select your acid, if you learned one commercial acid had a high degree of inhibition, but you couldn't select your pipe because you are going to put your acid—

Mr. Lyon: Why not?

Mr. Owen: Because you can't go around the country and say I will only treat wells with certain pipes in. The oil companies use all these different kinds of pipe, and this defendant treats wells equipped with all those different kinds of pipe, and they don't go around and say I will treat a well that has this pipe, but I won't treat one that has a different kind of pipe in.

By Mr. Owen:

Q. Doctor, in your testimony yesterday, you gave the results obtained in corrosion tests of the samples Nos. 5 and 7 from the Stella Wilcox well treatment, Nos. 12 and 12-B from the Zahn well treatment, and two samples numbered 15 from the Crawford well treatment? A. Yes, sir.

Q. Will you state whether or not you consider those samples of acid to contain a relatively small amount of a corrosion inhibitor, as that term is used in the Grebe and Sanford patent, and give your reasons for any opinion that you may express? A. It is my opinion that they do contain a corrosion inhibitor, and that that inhibitor is present

in relatively small amounts. The evidence presented yesterday showed that in each of the tests made, with each of the acid samples from the wells mentioned, that a relatively large reduction in corrosiveness was obtained. By reduction in corrosiveness, I, of course, refer to the fact that these acids gave relatively lesser corrosive action than chemically pure acid, which contains no inhibitor. If one were to obtain the average per cent reduction in corrosiveness represented by the three samples tested from the Stella Wilcox well, for example, on the strap iron, it will be recalled that that value was 44, those samples on the average were 44 per cent less corrosive than the corresponding blank samples of the same strength. The average of the two samples from the Zahn well, the strap iron gave a percentage average reduction in corrosiveness of 45 per cent. The average of the two samples from the Crawford well gave an average reduction in corrosiveness of 70 per cent. It is shown also that substantial reductions in corrosiveness were obtained with each of these acids against similar pieces of metal cut from different oil well pipes. I don't know that it is necessary to repeat my figures of yesterday of the reduction in corrosiveness found, but if one were to take, for example, the average reduction of corrosiveness represented by the Stella Wilcox sample as 44, the Zahn samples average 45, Crawford 70, the average value of those three would be 53. For corresponding acid samples in National Supply Company's pipe, the average of the values would be 31½; of the Oil Well Supply Company's pipe, the average of the values would be 38½; with the Atha Supply Company's pipe, the average of the values would be 51½.

The taking of these average reductions and noting what the average of those values would be in some of the values just mentioned divided by four, for example, would give an average reduction in corrosiveness of 44 per cent which figure, it seems, represents pretty fair value representing the reduction in corrosiveness of these different acids as a group against the different metals taken as a group.

The Court: Where do I find in the patent the language you referred to?

Mr. Owen: It is in a number of claims. For instance, it is in claim 7, "A relatively small amount of a corrosion inhibitor."

The Court: One is enough. Let me see, there was something I was going to ask you about. What do you understand a relatively small amount of corrosion inhibitor refers to? I take it it always refers to at least two things, when you say one thing relative to something you have got that other something always? A. Yes. Well, in connection with this particular patent I would have in mind a value relatively small, meaning something under, say, 5 per cent.

The Court: Well, why? This is for the benefit of the public and the world, and for chemists, probably. Skilled chemists, to help the public.

Mr. Owen: The statement in the patent itself, "The amount of arsenic compound added may be varied, but we have found that from one to five per cent thereof, based upon the weight of the solution, will be satisfactory for the purpose." That is what the patent states about the relative amount.

The Court: But, it is relative to what?

Mr. Owen: Relative to the volume of acid, I understand. A. Yes. That is as I would understand it.

The Court: All right: That is what I thought.

Mr. Lyon (Interposing): Is it relative to the volume of acid, or relative to the weight of solution as stated in Line 87? A. It might be either, and I still would call it relative because it would be not so different from the five per cent.

The Court: Now, my next thought was what would you say when I refer to this commercial acid we have, whether or not that would fit that definition. A. The question being does it appear that the commercial acid contains a relatively small amount of inhibitor? Yes, I am inclined to think it does.

The Court: Does it fit the rest of the definition, "Relatively small amount of a corrosion inhibitor, permitting the acid to act upon the rock formation surrounding the well cavity while applying pressure upon the solution and withdrawing the spent acid"? A. May I have that reference, Your Honor? That is in the body of the patent?

The Court (indicating): I was reading right here. I am asking about what Mr. Owen called my attention to. Claim 7 is what you have. You have it right. A. Yes.

The Court: I was using the claim he called my attention to. The question was, first, whether or not that early description of a relative—containing a relatively small amount of corrosion inhibitor would apply to the commercial acid that you tested, and you said yes, it would. Then I asked whether or not your answer would stand that it applied also to that later part of the claim, in other words, does it apply to— A. (Interposing) Permitting the acid to act upon the rock formation.

The Court: Surrounding the cavity while applying pressure upon the solution and withdrawing the spent acid. A. Yes, Your Honor, I believe it would.

The Court: Well, then, so far as you can see the entire claim reads on and would apply, with your definition, to that commercial acid just as well as it does to the defendant's acid? A. Yes. The only point I would feel that the author of the patent had in mind, an inhibition sufficient to serve for practical purposes, while a slight inhibition might not be sufficient to put the acid in such condition that it would be a practical inhibitor.

The Court: Now, I won't attempt to bother my good friend the Doctor with this further, but I call counsel's attention to the decision in the balloon tire case, wherein they had claims for larger tires, but I never found out and the Court of Appeals never found out how much larger they had to get to get within it, and how small they could get to keep without.

Mr. Owen: Well, I think, Your Honor, that the claim must be read with the purpose of the invention in mind as

it is stated in the specification, and while it is true that these commercial acids could and do contain relatively small amounts of something, we don't know what, different things, perhaps, so that they are slightly less corrosive than chemically pure acid, nevertheless those commercial acids could not be used in a well to obtain the objects sought for and obtained by the Grebe-Sanford invention.

The Court: Well, they never tried it.

Mr. Owen: For this reason: In the first place, the Grebe-Sanford invention gives examples of what they consider to be relatively small amounts of corrosion inhibitor, and it gives one to five per cent. In the second place, one of the objects, as we have already pointed out, of the invention is to insure the delivery of the acid in its, practically its full strength, so that it will operate in the formation. In other words, the object of the invention or one of the results of the invention is to prevent the acid from spending its strength on the pipe or metal with which it comes in contact.

The Court: Has anybody shown me that five per cent will not eat into the pipe?

Mr. Owen: Well, we do know that less than five per cent of a number of the inhibitors mentioned in the Grebe-Sanford patent will give very substantial protection. Right in that connection, I would like to ask the Doctor—

The Court (Interposing): What is substantial protection?

Mr. Owen: Well, substantial protection would be something that would make it commercial, I would say so that it would make it commercially possible to use the commercial acid, in acidizing oil wells, for this purpose, without adding something to it.

The Court: What were those figures I had up there, the first figures for the top column? A. For the strap iron, 15.0 per cent reduction in corrosion.

The Court: Yes, that is what I thought, reduction in corrosion. Well, right over that we get the Atha has a better reduction even than that. You will have to get after

them. You will have to sue them. They are doing a better job than the others.

Mr. Owen: I think Your Honor has a little misconception there. This merely shows what defendant's acids did to the Atha pipe. That doesn't show Atha is using the acids.

Mr. Lyon: Those are not defendant's acids. Those are commercial acids.

The Court: What was it you said?

Mr. Owen: I said that those figures do not show, are not intended to show, what the Atha Supply Company is doing but they are intended to show what the effect of these different samples of acid have on different pipes, and one of them, the Atha, had a higher rate of protection than it did on some of the others, due, perhaps, to some peculiarity of the pipe.

The Court: That is the iron, isn't it?

Mr. Owen: That is the iron.

The Court: Well, all right. On some kinds of iron is the point, the Detroit Chemical Company wouldn't give half the protection that the next one right down below gives.

Mr. Owen: Which table? A. Yes. The DuPont you have in mind.

The Court: And right in my own mind, I am complimenting the Doctor and counsel for plaintiff for putting all these in. That is what I like when we have experiments. I don't like—it makes me a lot of trouble where they will make several experiments—to have them just bring me the ones that prove some particular theory. I like this way of doing it, and I compliment the Doctor for doing these different things and you for letting me know about it. So we can conjure with them in this way. Not only interesting but likely to reach right and true results with these statistics. I can gather statistics, if I do it unfairly to prove almost anything. That is the reason we have to watch it so carefully. On the other hand, I believe in it because we are thorough about it, careful about it, and we do check up on our theories. So not at all in the way of criticism but in

compliment to everyone, I am just calling attention to the fact that I can almost dispute any theory you put up because there are those other ways; the one which I dispute may be unfair, and may be more unfair than the theory you set up, but the situation deals with relative things and you do get pretty near to that tire case. You have to be pretty careful. It pretty nearly has to be (if you are dealing in degrees) it pretty nearly has to be formulas, something of that kind, or the public aren't greatly helped by it.

Mr. Owen: Well, may I say a few words right on that point? That in reading this patent the person skilled in the art who attempts to carry out the invention goes to the specification to ascertain what the claims mean. And if he goes to the specification in this patent he will find not only specific examples or a specific example of how much of an inhibitor to place in a certain amount of acid, but he will also find suggestions that other inhibitors, several other inhibitors, as examples, may be used and he says he has found from 1 to 5% of the inhibitor is satisfactory, and the amount varied perhaps according to the activity of the inhibitor. Now, I am going to show by the Doctor that these ranges of inhibition which he has found to be present in the fendant's samples, are well within the ranges that will result from carrying out the invention by using a number of the inhibitors which the patent names.

The Court: What is the percentage of the lowest one, what percentage of the inhibitor is there?

Mr. Lyon: Your Honor, that is what I would like to know. Do you claim, Mr. Owen, that the defendant's well acid contains 1 to 5 per cent of anything which you call an inhibitor?

Mr. Owen: No.

Mr. Lyon: It does not contain 1/25th of one per cent of anything you call an inhibitor.

Mr. Owen: No, we do not say that it does, but we say that it does contain something that has the inhibitive effect of the materials mentioned in the Grebe and Sanford patent, when used from 1 to 5 per cent.

The Court: Is it anywhere suggested that anything less than 1 per cent could be used?

Mr. Owen: No, but—

The Court: You see, there, you are relying on this relatively small amount.

Mr. Owen: Yes. The claim does not say 1 per cent or less than 1 per cent.

The Court: Then where are we going to start, and where are we going to stop? There isn't any suggestion of a definite amount, it just said "relatively." You see we are getting right back to my balloon tire case, where I said that I never could make any calculation unless I knew—I didn't know when they were bigger—bigger than what?

Mr. Owen: Of course the object, as I stated before, must be kept in mind, and if the patent gives a specific example of what could be used for that purpose—

The Court: No, you see, we get right back to the balloon tire case. You get the balloon tire just as quickly as you get any oversize, and you keep on. But where are you going to start, and where are you going to stop? Here you can get the effect of this just as quick as you get any in, you get some of the effect, and you can keep right on until you get to the point where it will not eat any iron.

Mr. Owen: Yes, you can.

The Court: Well, now, how far down the scale the other way are you going to do it? Just put in a very little, and you help it a very little.

Mr. Owen: I think you have got to go to some practical point which makes it possible to use this hydrochloric acid in an oil well without doing severe damage to the pipes.

The Court: You say the lowest was what per cent?

The Witness: The lowest that I reported, or lowest value expressed in average values of the Stella Wilcox samples, while using strap iron, the value was 44 per cent reduction in corrosiveness; the lowest value I found was with the National Supply Company's pipe which is 25.

Mr. Lyon: That isn't the value the court asked for.

He is asking what per cent by weight of the solution was the inhibitor in there.

The Witness: Oh, I see. No statement has been made as yet as to the inhibitor or the amount of inhibitor.

The Court: Can you tell me what per cent? A. Your Honor, I believe that that is quite likely to be the next thing that counsel had in mind developing, the exact amount.

The Court: You have the figure for it? A. I have the figures and will present it this morning.

Mr. Lyon: It is less than 1/25th of a per cent by weight of a solution, you know that, don't you? A. It may be. I won't say exactly until we get the figures.

The Court: And, you have the figures exactly, so we will get it for this commercial? A. I have the figures, yes, sir, Your Honor.

The Court: That is fine.

Mr. Owen: I want to call attention to one thing before we pass this point, and that is that the claims of the patent do not specify 1 to 5 per cent, and the 1 to 5 per cent is the amount which is recommended in case arsenic is used as the inhibitor. Now—

The Court (Interposing): What we started out with, I was criticizing the patent because it did not give a formula, and you were suggesting that as getting away from that criticism. That is the only way we got into that Michigan. I was saying if this patent doesn't give any formula, what does it do, and where are we going to stop? If you find the least bit in, is it going to be an infringement?

Mr. Owen: I think that the amount, that is the per cent of the inhibitor to the total amount of the acid, is not the important thing but it is the effect. If you can find some other inhibitor by using one-half of one per cent, or a quarter, or one-tenth will be as effective as the 1 to 5 per cent of what the arsenic is, why, then, you are practicing this invention.

The Court: In other words, nowadays since this patent if the natural and economical way of making hydro-

chloric acid gets some of that inhibitor in, since this patent came out they can't use that particular kind to treat the wells, and they could before?

Mr. Owen: No. I think that this patent—

The Court (Interposing): If nature put it in. If you make it. I take it some of these hydrochlorics that they call commercial, that they find that in those it is cheaper than it would be if they had to go and take that out, isn't that true, Doctor? A. That may be the case in some instances. I—

The Court (Interposing): Have you any idea at all with these commercial hydrochloric acids, putting some of that in to treat wells in there, and get better results, or have you got the idea it has always been in there ever since we began to have commercial hydrochloric acid? A. I think my opinion would be that practically all commercial hydrochloric acids have contained some ingredients that might have had some effect, yes.

The Court: That was my idea.

Mr. Owen: I might call attention, Your Honor, to a chemical case I had a number of years ago in which the process was for the manufacture of arsenate of lead, and the claim called for reacting upon lead oxide with arsenic acid in the presence of a catalytic agent. And, the defendant at first infringed by adding a catalytic agent to its solution definitely for that purpose. A decree was entered and the defendant then changed its process and discontinued the addition of any catalytic agent to its acid, but in manufacturing its acid it left in certain impurities which acted as this catalytic agent, and our Court of Appeals said that it was preventible. We showed that it was preventible. It didn't need to get that in. It was simply carelessness in the process of manufacture, and the Court of Appeals held that it was an infringement regardless of how it got there.

The Court: Somebody had a patent that makes all the world be careful.

Mr. Owen: That is what every patent does, yes.

The Court: I don't think it makes people careful, for instance, about what I do down on the farm. If I have been

doing it right along, and they get a patent on something, I can keep on doing what I have been doing, surely.

Mr. Owen: Oh, yes, undoubtedly. We can't get a patent that can stop you from doing what you have been doing.

The Court: Supposing back in 1895 when they acidized those wells, do you suppose they had to have absolutely pure stuff?

Mr. Owen: No, I don't think they did.

The Court: But, you can't use that stuff now?

Mr. Owen: Yes, they can. We don't content this patent is entitled to any such construction as that. We don't contend we can prevent anyone from buying commercial acid and using it for treating oil wells to increase their production, unless that acid has been deliberately spiked in order to make it suitable for this purpose, and I say if any acid manufacturer does that—

The Court (Interposing): Does it make a difference? One chap that is careless and makes it, and you cay buy the acid with it in, and another chap is a careful fellow and he puts his up to the same height with care, and you can't buy that acid.

Mr. Owen: No. He wouldn't put it up the same height with care; he would put it up deliberately for that purpose.

The Court: But, you see, the varieties you get in commercial acid. And, if I picked deliberately, I take it, from the bargain counter my acids, and I was going to say my irons, but yet if I was drilling a well, and this patent was around me, why don't I pick my iron I use in my well, and pick the acid, and I can do a pretty good job here by doing these two now.

Mr. Owen: Well, I would say if you pick a commercial acid that is not especially prepared to avoid this patent, why, you would be safe.

The Court: Well, I pick my iron, too. I am going to pick them both. I am going to pick the one that will do the best job, and the other.

Mr. Owen: If you want to do that, we won't object to it.

The Court: I will get as good a job here by doing these pickings, I think, as the defendants.

Mr. Wiles: Oh, no.

The Court: I don't know. If I pick the highest iron and the lowest acids.

Mr. Wiles: No. The best here is 18 per cent, if you got it all, and those fluctuate. The defendants are much higher than that.

The Court: That is 18 what?

Mr. Wiles: 18 per cent reduction. That means it corrodes 82 per cent of the normal corrosion.

The Court: I haven't found out yet the percentage, and you don't say anything about corrosion. You talk about per cent.

Mr. Owen: We talk about reduction in corrosiveness.

The Court: Not in your claim.

Mr. Owen: Oh, no. We don't say anything there. We say, "relatively small amount of corrosion inhibitor."

The Court: I take it that that is talking about percentage, isn't it, where you talk about that amount there; I think that is talking about percentage.

Mr. Owen: I think so, I think that means that you could take an amount that is sufficient to fulfill the purposes of this invention.

The Court: Well, you have an invention then that if I want to have my pipe eaten, for some reason, I do not infringe, but if I do not want to have it eaten, I do. I use the same thing, I put it down there, I have been using it, I have got some lime on my pipe, say, and I want to get that off, so I put it down there, and if it eats off, on the walls of my well, I will get more oil, and if my purpose was to get that off, I have not infringed, but if that was not my purpose, and I knew it, I have infringed. Well, I didn't know that there was even such a law. I know, criminally, we put folks in jail because of their intent, but I didn't know in this patent game that we did that.

Mr. Owen: I don't think we do, Your Honor. I don't think that you would be infringing if you used commercial hydrochloric acid that was not specially prepared and spiked for this purpose to do anything that does not come within the terms of these claims.

The Court: But supposing it had been specially spiked, but I did not know it. I look at these figures, and I see this 18.4 over there, and I say, "That is the boy I want," and I go and buy that. If it has been specially spiked, I infringe. If it has not been specially spiked, I don't infringe.

Mr. Owen: Then I think it would be up to us to stop the manufacture of that acid and the sale of it for that purpose.

The Court: Then my infringement depends on my intent and not on what I do, but what my intent is. Maybe that is the patent law, but I didn't know it.

Mr. Owen: You see, my associate calls my attention to this point which I evidently haven't made clear, that this patent covers the making of the acid less corrosive and that—

The Court (interposing): Less corrosive than what?

Mr. Owen: Less corrosive than it was, than it would be under ordinary commercial processes of manufacture. And making it less corrosive for the purpose of using it in making use of this invention. Now, that is what the defendant has done in this case, Your Honor. We will show that the defendant is—we have already shown that the defendant's storage acids are less corrosive than this Detroit sample of commercial acid, but more corrosive than the average of five commercial acids, and we will show that the defendant does not purchase this acid from the Detroit Chemical Company but from other companies, Pennsylvania Salt and General Chemical, whose acids have been or are among the five commercial acids that were analyzed here.

The Court: You are emphasizing this part, the method of increasing the output of an oil well which comprises introducing into the base of such well—then if I put it down

in there and then would apply some electricity and something to it, such that I changed it and let it do its dirty work, I wouldn't infringe, I take it, but if I do it before I put it down into the well, then I infringe. Is that the breadth of this patent? Suppose I shoot this lead and electricity, or whatever it is, down in there after I have got it in there, and then make it work. You claim I infringe then?

Mr. Owen: No, I would say not.

Mr. Conner: All of these samples—

The Court (interposing): I think you want to disagree with him, don't you?

Mr. Conner: No. I just wanted to get this statement over with. All of the samples that plaintiff is relying on to show infringement were obtained out of the truck tanks of defendant on the surface. That is, we obtained samples of the acid on the surface and not of what went into the well, but if we had not obtained the samples that acid would have gone into the well.

The Court: Suppose you made it that way by the container that you carried it in. You claim that infringes just the same?

Mr. Owen: Yes, sir; we do.

The Court: Now, what I was saying, suppose you put it down into the well and then you put your lead down there and you let this dirty work go on.

Mr. Owen: That would not infringe.

The Court: Then you wouldn't infringe?

Mr. Owen: No; it would not.

The Court: All right. Then you have got your patent narrowed down to a point where it is because they do it, they apply this, let it come in contact with lead as it is approaching the well and before it goes down into the well, but if they wait until it is down in there it wouldn't infringe.

Mr. Owen: I think that is true.

The Court: All right.

Mr. Owen: I will tell you why. If you put your acid

down in the well and keep it out of contact with the pipe, you don't need an inhibitor when you get down there, but you need an inhibitor when it goes down through the pipe. And you need it for two purposes. First, to protect your pipe from corrosion or being eaten up. Secondly, to insure the delivery of the full strength of the acid into the formation where it is intended to do its work. Now, if you did what Your Honor says, if you put this acid down into the well without inhibitor in and then added inhibitor when it gets down there, electrically or in some other way, why, you wouldn't be accomplishing the purposes of this invention, because you would be destroying your pipe to get the acid into the well. You would be destroying your pipe and your acid also. You cannot destroy one and not the other.

The Court: Even though it is perfectly good, they would be guilty of contributory infringement every time they hauled a tank load under your patent if they hauled it to a well where they were going to put it down.

Mr. Owen: Yes, they would.

Mr. Conner: This patent, Your Honor, does not cover or stop anybody from using commercial acid. Commercial acid was old—

The Court (interrupting): They could put it down into the well.

Mr. Conner: It had been done before.

The Court: Not that I know of.

Mr. Conner: I think Frasch and Van Dyke did use glass carboys.

The Court: But you agree before you got your patent it would be all right for them to have hauled the commercial acid to the well with a lead tank and pour it down into the well?

Mr. Conner: I see no reason why what you were doing before the patent was taken out couldn't be continued. This is what we do—merely take commercial acid and improve the acid to make it less corrosive than it was before. So you have less danger and trouble with corroding of equipment.

The Court: It doesn't matter how little you do that?

Mr. Conner: Obviously we couldn't claim the infringement existed if the corrosiveness as effected by the alleged infringer is still within the degree of corrosiveness enjoyed by the commercial acid. As the proofs come out we will show defendant's storage acids all enjoy the same degree of corrosiveness, but the acid used in treating these wells is way out of that class.

The Court: But they had already learned to keep their stuff before your patent, this commercial acid with something in it that increased this inhibitor.

Mr. Allen Owen: Not before.

Mr. Wiles: No, sir. That was all gotten up afterwards.

The Court: I say before your patent—

Mr. Wiles: The defendant's patent says take inhibited acid with the inhibitor in it and carry it in a common iron barrel. Now, that isn't what the defendant is doing at all. The defendant takes presumably uninhibited commercial acid, then puts it into a special tank that is got up for the purpose, we charge, of adding an inhibitor, the natural corrosion the commercial acid puts upon it. A slick trick for getting a tank fixed up to add the inhibitor mechanically.

Mr. Wilber Owen: There was no delivery of acid in steel tanks before the Grebe-Sanford invention. They used wooden tanks, not only around the plant in Midland but for deliveries outside. You can't show a single instance where a steel tank was used for delivering acid around the country, but after the Grebe-Sanford patent issued it became known—this defendant discovered, at least—that instead of introducing an inhibitor into its acid as it did during the year 1935 it could get that inhibitor in the acid by fixing up an especially prepared tank. So that although the acid wasn't inhibited when it left the storage place, it became inhibited during the passage in transit to the well where the treatment was to be made, and therefore when the well was treated it was treated with inhibited acid.

Now, there is no reason why acid cannot be delivered today as it was before the Grebe-Sanford patent, either in rubber-lined tanks or in wooden tanks, or in carboys, but because the defendant owns a patent on a means of protecting a drum for shipping inhibitors or pickling compounds doesn't give it a right to use that invention in order to create an inhibitor during the transit of its commercial acid to the well. There is nothing of that kind in the Gravell patent. It wasn't intended to do that, and the fact that Grebe-Sanford have a patent on the use of that inhibited acid at the well for a specific purpose should not be limited, I submit, to cover the addition of inhibitors to the acids that are so used. It covers the use of inhibited acid. And when that acid is inhibited, whether inhibited by the addition of substances at the well or at the tank station or in transit, doesn't make any difference in carrying out the Grebe-Sanford process.

The Court: I haven't read that patent yet. What are the claims in that?

Mr. Owen: You want the claims of the Gravell patent?

Mr. Lyon: Claim No. 1 says: "The method of preventing an acid solution from attacking a steel transportation or storage drum containing it which consists in dissolving in the said acid solution a material capable of precipitating a substantial protective coating on steel, and allowing the admixture to contact with the inner steel surface of the drum."

The Court: Now, what did you say about the question of putting it in a pipe line?

Mr. Owen: It does not say anything about putting it in or through a pipe line.

The Court: What do you say as to whether, if they put it in a pipe line there and transport it, or, you do that,—can you do that without infringing?

Mr. Owen: Now that Your Honor has asked that question, we say that the defendant does not protect the well tubing in the manner specified in the Gravell patent; that it protects the well tubing by placing—either by placing an

inhibitor in the acid, or in forming the inhibitor in the acid during the transit from the storage tank to the well.

The Court: What do you say about whether the defendant's patent covers putting an inhibitor in it, we will say the same kind that you do, in order to prevent their tanks from corroding? Does their patent cover that?

Mr. Owen: Their claims are broad enough to cover that. We say that was not new.

The Court: Then if they are that broad, why was the pipe line—if they did use that to transfer some of the stuff around through the pipe line, why wouldn't it be an infringement of their patent if you took—if you put the inhibitor in, the same as you do, and let it run through a pipe, to transfer it around your premises?

Mr. Owen: That claim is directed to the protection of the drum in storing or shipping acid.

Mr. Lyon: It says "transporting."

The Court: What do you think about their patent? I am getting off the track, I know that; this is prior art. What do you think about their patent as to whether or not it clearly covers inhibiting by this method they are following now, or does it also cover not only that method but putting in the inhibitor like you put it in? Is there a patent broad enough to cover both of them?

Mr. Owen: Assuming that their claims are valid, they cover placing an inhibitor in the acid for the purpose of protecting the drums, storage drums and shipping drums.

The Court: Do all these inhibitors inhibit by putting a deposit on the thing they are going to eat so that they can't eat it, so that the acid can't eat it, or is there something in there that just dulls their teeth so they can't bite? Which is it?

Mr. Owen: Both, Your Honor. There are some inhibitors, I believe, that form a protective coating on the surface of the metal, and others that dull the teeth of the acid so it can't bite.

The Court: Doctor, to get back to chemistry here, in the defendant's inhibitor does that put a mask on the girl

so they can't bite her, or does it dull the teeth so that it can't bite her? A. I am not as familiar with the patent referred to as I, perhaps, should be, but from the statements that have just been made it appears that a coating is formed on the metal so the acid does not get to the metal. That seems to be the intent.

The Court: How about the plaintiff's way of doing it? What about that way? What kind of inhibitor is that? Is that a mask or dulling?

Mr. Lyon: The plaintiff uses arsenic, and that is the material or patent in suit we say is the one that does it. They use the very material that is in our patent.

A. To a degree, Your Honor, I feel that it forms a coating, but, furthermore, as it forms a partial coating it sets up a potential in the system such that the acid then cannot so readily react with the iron so that it is stopped in two ways. So, we may say it puts on a coating and also tends to pull the teeth.

The Court: Is that true of the defendant? A. I believe it is.

The Court: Is that true of all of them that you worked with? A. In the case of the inhibitors I think it is quite true.

Mr. Owen: Have you made any tests of the samples Nos. 5, 6, 8, 12, 12B, and 15, with a view to ascertaining what they contain that might cause them to be inhibited? A. I have made such tests and found them to contain small amounts of copper, lead and iron in solution.

Q. Will you explain how you determined that? A. I determined by quantitative analyses the amount of the copper, lead and iron in solution. Specifically, the iron was obtained by the phena-thioline method. The lead was determined by the di-thizone method. The copper was determined by the thio-carbonate method. I have given the percentages of copper, lead and iron which I found in those samples in parts per million by weight. I have the data in tabulated form in Table No. XI.

(The table was offered and received as PX-160.)

Mr. Lyon: What do you mean by parts per million; per million of what? A. Exactly that. Parts per million by weight of the material found in respect to the solution.

(The Witness): The analyses were made on the samples mentioned. Starting with sample No. 5 from the Stella Wilcox well, which contained 14.8 per cent hydrochloric acid, there was found 2.9 parts per million of copper, 410 parts per million of lead and 480 parts per million of iron. From the sample No. 6 from the Stella Wilcox, with the same acid concentration, copper 3.6 parts per million, lead 420 parts per million, iron 470 parts per million. And, in sample No. 8 from Stella Wilcox the copper content was 4.2 parts per million, the lead 420 parts per million, the iron 470 parts per million.

Now, the average metal contents of the samples taken from the Stella Wilcox well, that is samples 5, 6 and 8 were, of copper, 3.6 parts per million, lead 417 parts per million, and iron 473 parts per million.

The Court: Does that mean, your first column 14.8 now isn't in the same terms as the next column? A. No, Your Honor.

The Court: This is the per cent of the solution? A. That just happens to have been the concentration of the acid.

The Court: I understand you analyzed to get this per cent, or did you analyze the whole thing and just say 14.8? A. Well, what would be done would be to take a given mass of solution and then analyze that and calculate how many parts of copper per million parts of the mass of the whole.

Mr. Owen: Now, will you explain the other figures on the Exhibit PX-160? A. Analyzed in a similar fashion, the samples from the Zahn well, sample 12 contained 2.7 parts per million of copper, 410 of lead, and 410 of iron.

Q. Right at this point, Doctor, I am going to ask you to tell the court of the incident you explained to me where merely stirring something with a copper spoon had a decided effect. Will you tell the court what that was? A.

Well, I think presumably the thing I referred to at that time was rubber latex. The rubber latex is often called the milk of rubber, the white fluid material which, if allowed to flow out on a surface, and dry, will become rubbery and elastic, and one can pick it up and stretch it. But, I have done this experiment. I have stirred some of that latex in a beaker with a copper wire for a very short time, and then poured some of that latex on the surface and it would not set, it would remain indefinitely sticky and gummy. And, the use of latex as coatings is often prohibited by the fact that traces of material will greatly alter its properties. That small amount of copper will greatly alter the property of latex.

In the same connection, if I may mention it, speaking of traces of copper, I was curious to see what references I could find with reference to the effect of that. I found this statement which occurred in Alexander's Colloid Chemistry published in 1937, that less than one part per million of copper in coffee can be tasted, which seemed a bit surprising at the time. And then I found another statement to the effect that six-tenths of a part of copper per million are essential before free-swimming oyster larvae will set. Copper must be present, but that small amount, six-tenths of a part per million, is sufficient.

Then I found another statement, how true I do not know, that traces of copper, such, for example, as are found in grandmother's copper preserve kettle, inhibit bacteria and moulds, and minute amounts of copper sulphate have been used to kill troublesome algae, etc., in reservoirs Those were references that I found in some of the chemical literature.

Q. (By Mr. Owen) Doctor, did you also analyze the storage tank samples No. 14 and 20 for their metal content? A. Yes, sir, I did, and have a table showing the results of my analyses.

(The table was offered and received as PX-161.)

The Court: Before you leave this other one, Doctor. Which of those are inhibitors? A. Well, Your Honor, I

have made quite a detailed study of that, and I have a table which I expect I will present shortly showing the effect of these things. It is probably no anticipation to state that the copper is really the bad actor there.

The Court: Of course, iron is not at all? A. Very little, if any.

The Witness: PX-161 gives the analysis of the storage samples. The N14B, to which we have previously referred, full strength, not diluted, showed 1.5 parts per million of copper; 10 parts per million of lead; and 27 parts per million of iron. Corresponding values were obtained for the other samples. S14B showed 1.5 parts per million of copper; 8.7 parts per million of lead; 13 parts per million of iron. Sample N20B, 0.37 parts per million of copper; 5.5 parts per million of lead; 15 parts per million of iron. Sample S20B, 0.56 parts per million of copper; 16 parts per million of lead; 21 parts per million of iron. These are the amounts of those metals which I found in the samples of acid in the strength in which I received them.

I have another table showing the metal content of these same samples, diluted to the strength of the well samples. That is my Table XIII.

(The table was offered and received as PX-162.)

Mr. Owen: PX-161, Your Honor, is before the acid is put in the truck and PX-162 is after it is put in the truck and diluted about 50% with water. The purpose of PX-162 is to enable us to compare the amounts of these metals in the diluted storage samples with those in the truck samples (PX-160), the dilution being the same on both of these exhibits PX-160 and 162.

The Court: Maybe the Doctor can help me a little by some suggestions as to why from one tank he got twice as much copper in it as the other. That is in the tank, is it? A. That is the storage tank, Your Honor.

The Court: Well, in the storage tank what would be the explanation of that? What could be? I hadn't hoped for the best, but what do you guess it might be? A. Unfortunately I haven't an explanation for that. In this case

it is evident copper got in somewhere. The acid may have come in contact with that copper. Where that copper may have been, we have no evidence, so far as I am concerned that would show that.

Mr. Owen: I think, Your Honor, the differences in the amount of copper in the storage samples might and probably did result from the fact that the defendant bought its acid from two different sources, and they had two tanks, so when they would get in a carload from one source they put that, perhaps, in one tank which was run down, and when they get a carload from another source they put it in the other tank.

Mr. Lyon: Those are wooden tanks. I don't see how the copper got into the wood. I don't know.

The Court: Let's see; can I go back to the other formula that you are talking about the acid, where they bought the acid? Can I go back and trace what kind of acid they bought? They must have bought some from one of these, Pennsylvania Salt Company or General Chemical Company.

Mr. Conner: Yes, the third and the fourth acids on the list.

The Court: Yes. I will just look at these and see how they go. Well, on the whole, they are buying about as poor an inhibitor as there is, aren't they? The poorest. They have got the two poorest inhibitors there are, isn't that right? A. Just about, as far as these tests indicate.

Mr. Wiles: That means the poorest, probably, of the commercial acids.

The Witness: The amount of copper found in the average of the two Zahn samples, namely 12 and 12B, was 3.1 p.p.m.

The Court: You are looking at PX-162. A. It happens, Your Honor, that I am referring to something beyond that in my own notes. I have extra copies of these tables, I find, for making the comparison.

(The table was offered and received as PX-163.)

Witness (continuing): On the table to which I am referring now is found the data, analysis data of samples 12

and 12B from the Zahn well, the analysis of N14B diluted to the same strength as the samples from the Zahn well, which was 14.5 per cent, and the analysis of the sample S14B diluted to the same extent. The last two are the storage tank acids, and the first two are the truck tank acids.

Mr. Owen: I might state, Your Honor, that this Zahn well treatment was made on the day following the taking of the N14B and S14B samples.

The Court: Now, then, let me see. I really don't see, so I will think out loud and have you correct me. The 12 Zahn is just as it was taken from the defendant's Zahn truck?

Mr. Owen: Yes, at the well. That is also true of 12B. There were two samples taken at the same time and split, so that 12 and 12B are really parts of the same sample, from the same truck. The N-14-B was taken from the north storage tank and the S-14-B was taken from the south storage tank.

The Court: And after you have taken it, you have diluted it down so it would be the same acid strength as that that you had taken from the truck. A. That is it.

The Court: Now I have the whole picture.

The Witness: It will be noted then that the composition of the first truck tank sample indicated as 12 Zahn contained 2.7 parts per million of copper, 410 parts per million of lead, and 410 parts per million of iron. The other sample, 12B, contained 3.5 parts per million of copper, 460 parts per million of lead, and 350 parts per million of iron; or an average of metal contained in these two samples, copper 3.1 parts per million, lead 435 parts per million and iron 380 parts per million.

Of the storage tank samples, N14B contained 0.72 parts per million of copper, 4.8 parts per million of lead and 13 parts per million of iron; while the sample taken from the other storage tank, S14B, and diluted, contained 0.69 parts per million of copper, 4.0 parts per million of lead, 6.0 parts per million of iron; or the average metal content of these

two samples is, of copper 0.70 parts per million, of lead 4.4 parts per million, and of iron 9.5 parts per million.

Now, comparing the values, first of copper, it will be seen that the copper content of the truck tank sample, the average value is four times that of the storage tank sample, approximately four times.

The Court: You mean the quantity, the weight. A. The quantity, that is right, Your Honor. The amount of copper per unit weight is four times as great in that truck tank sample as in the storage tank sample. Of lead there is about ninety-nine times as much in the truck tank samples as in the storage tank samples. And of iron about 40 times as much in the truck tank samples as in the storage tank samples.

The Court: I can work out a theory as to the increase in lead and iron, but I have a lot of trouble about that copper. A. I have had trouble, also, Your Honor.

The Court: You find it quite easy, don't you, to explain why the lead and iron increases? I don't know about the proportions or the amount. A. Yes, Your Honor. After having read the depositions of the structure of the truck tanks, and so on, why, I can understand where the lead might have come from, and the iron. And, there is some copper in the lead which dissolved.

The Court: That may be the answer, then. A. That is, probably, a part of the answer. Whether there is enough lead there—

The Court: It is usual to have some copper in lead? A. It is not uncommon at all, and I have reasons to believe that in this particular lead there is some copper.

The Court: That may be understood, then. If there is a trace of copper in lead, at least for the present I can see how, if the lead is coming off and going over to the iron, and there is some copper in it— A. (interposing) That copper is bound to go in, yes. Such copper as is present will go in.

Mr. Lyon: As I understand it, witness, a trace of

copper is not an uncommon impurity in lead, is that right? A. In commercial leads copper is sometimes found.

The Court: Then you are inclined to think—I will put it this way: have you figured out any better theory now as to how that could happen, than that? A. Well, I haven't figured out a better theory to account for some of the copper, at least.

Referring to my table XIV, PX-163, the last line at the bottom of the page means that there is approximately four times as much copper in the Zahn samples as there was in the diluted 14B samples, and 99 times as much lead and 40 times as much iron.

I made up a similar table showing the relative increases of copper, lead and iron in the Stella Wilcox treating acid as compared with the 14B storage acid.

(The table was offered and received as PX-164.)

The Witness: In this table is given the data showing the amounts of copper, lead and iron in the three samples from the Stella Wilcox well and from the two storage samples labeled N14B and S14B. The Stella Wilcox samples are numbered 4, 6 and 8. Perhaps it would be sufficient to give the average copper, lead and iron content in the Stella Wilcox samples, which would be 3.6 parts per million of copper, 417 parts per million of lead and 473 parts per million of iron.

Q. And how much increase was there in the copper, lead and iron contained in the Stella Wilcox samples over that contained in the 14B storage samples when diluted to 14.5% strength? A. The average metal content of the two storage samples was 0.70 part per million of copper, 4.4 parts per million of lead and 9.5 parts per million of iron.

The Court: Isn't that just the same as in PX-163? You didn't bother to run it again? A. No, Your Honor. Simply we made the one analysis, and a comparison then of the metal content of the Stella Wilcox samples to the storage samples mentioned showed 5 times as much copper in the Stella Wilcox truck samples as in the storage sam-

ples, 95 times as much lead and 50 times as much iron. It will be understood that those figures are approximate, although nearly exactly correct.

I have made a similar table comparing the Crawford samples No. 15 with the storage samples numbers 14 and 20.

(The table was offered and received as PX-165.)

The Witness: That table shows that the average copper content of the two samples 15 from the Crawford well contained 4.8 parts per million of copper, 53 parts per million of lead and 210 parts per million of iron. The average metal content of the four different storage tank samples examined had 0.46 parts per million of copper, 4.7 parts per million of lead and 8.9 parts per million of iron. That is an average of the four storage samples N14B, S14B, N20B and S20B diluted to 14.5 and 15.1% hydrochloric acid, respectively.

Mr. Owen: Now, is it clear, Your Honor, what these tables XIV, XV and XVI show? (PX-163, 164 and 165.)

The Court: I think so.

Mr. Owen: I will ask you, Doctor, have you analyzed any sample of the lead plate which you understood was taken from one of the defendant's truck tanks? A. We have.

Mr. Owen: That is one of the samples that has been covered by the stipulation. Mr. Babcock gave us one of those strips they put down in the tanks when we were taking testimony at Mt. Pleasant.

Mr. Lyon: That wasn't supposed to be necessarily one of the lead strips in these particular trucks. It was one of those they were using—

Mr. Owen: It was given to us as representative of the lead you were using.

Mr. Lyon: Was it one of the lead strips that came out of the tank?

Mr. Babcock: No.

Mr. Lyon: There might be variation, so far as I know, in lead strips. That is the only statement I can make

about it—that he gave you one. Had it been used at all?

Mr. Owen: I think not.

Q. (By Mr. Owen) Now, will you state what you found that lead sample to contain? A. We found the lead sample to contain copper. As to how much I am not sure I have the figures at my finger tips here.

Mr. Owen: Regarding our obtaining of that lead strip, we were taking testimony over at Mr. Pleasant and Mr. Edwards explained to us how they polarized their tanks by putting this lead strip down in the acid and attaching a storage battery to it, running the battery down. I asked him—"Q. Have you any of the lead strips in stock which you use in polarizing a new tank? A. Yes. Q. Here in Mt. Pleasant? A. I think so. Q. Would you furnish us with one of those strips if we pay for it? A. Yes." (Mr. Owen reading from testimony.) And he gave it to us. We went over to their storage warehouse, Mr. Edwards picked it out and gave it to us.

The Court: All right. I will admit the analysis.

Mr. Owen: I will say, Your Honor, I don't concede that the burden is on us to account for the presence of these metals in their treating acids. We found them there and we are giving Your Honor the benefit of what we found and of any possible explanation we can offer, but it is not a burden that we must sustain to show how they got there.

Q. (By Mr. Owen) Now, Doctor, you heard what I stated to the court about the possible sources of this copper but Mr. Wiles calls my attention to the fact that that is not testimony. Will you state where you think it might have come from?

Mr. Lyon: If the Doctor said he doesn't know, I don't see why we should have guesses. If they are relying on this copper as being what the defendant added, it seems to me if anybody is going to furnish evidence on that, he should lay a foundation as to knowing something about it. I don't understand the Doctor has ever seen the defendant's system or examined it. I don't even know what explanation he has had of it.

The Court: I will let him answer it.

A. Well, as I stated this morning, if lead contains copper, that copper will go in solution and we know that it is highly probable that the lead used contains some copper. That copper will go in solution. Now, if there is more copper in the solution than can be accounted for by the lead used, it must come from somewhere. The only obvious source would be from the equipment. Just how the tanks are put together, whether by chance there is brazing in the tank—as it seems to me I heard that word used yesterday—it would imply brass somewhere. I can't quite believe the tanks would be brazed. I am not suggesting that, unless perchance the tanks are brazed. The tanks may have some copper fittings; there may be valves or there may be copper in the pumps somewhere for transport of the acid, through which the acid would pass and pick up some copper. In other words, it appears the copper must come from some of the equipment, from somewhere. Not being entirely familiar with the equipment, it would be mere speculation to say where it does come from.

Q. Mr. Owens: It is in evidence that samples of Mt. Pleasant tap water were delivered to you. Do you recall having received them? A. I do.

Q. And, did you analyze them? A. I did.

Q. Could the copper in the defendant's treating acids used at the Stella Wilcox, Zahn, and Crawford wells have come from the Mt. Pleasant water used to dilute the storage acid? A. No. The copper content of the water was less than two hundredths of one part per million.

Q. Now, Doctor, have you conducted any tests to ascertain what, if any, effect the presence of small amounts of lead and iron and copper, or either of them, in approximately 15 per cent hydrochloric acid solutions has on the corrosive effect of the acid on iron or steel? A. We have conducted a fairly extensive series of tests of that type, tests in which small pieces of iron of the size previously described, strap iron 1 inch by 7/8ths by 1/8th inch thick, suspended in 15.1 per cent acid solution, 50 c.c.'s of said solution in the same type of container previously used, at

the temperature previously referred to, 85 degrees Fahrenheit, the same length of time, 16 hours. We have tested the effect of adding to originally pure acid different amounts of copper, increasing amounts, different amounts of lead, different amounts of iron, and then various combinations of two of each of these different materials in solution, and we have such data available.

Q. Also, as I understand, various combinations of all three of them, did you not? A. Yes, we did that also. We made one fairly extensive series in which we used combinations of all three of the metals: copper, lead and iron in combination.

The Court: Let me ask you as to your final conclusion on all this; do you find more copper and more lead and more loose iron floating around in this acid in the transportation tanks which you can reasonably account for than if they buy commercial acid, pump it in the ordinary way through the brass fixtures that are likely to be around, and into a tank with the lead in it, lead got it in,—do you find any more than you think would be accounted for in that way? A penny's worth in the water, perhaps. Take it together. Do you think you have found more of the free iron and lead and copper than could be accounted for in that way, if handled in the ordinary way? A. Well, it would seem that the acid must have been handled a number of times in one way or another between the point of manufacture and the point of storage in the storage tank, handled by various devices, and that would seem to represent about the normal amount of elements that one might expect the acid to take up in transportation or in handling and there is, of course, much more of these elements in the truck samples than we have found in such storage samples. That is about the best argument, it seems to me.

The Court: To put it in a rough sort of a way, in a wicked sort of way, do you think that they stuck some of this particular stuff in there? Is that your conclusion? Or, is it your conclusion that this can be accounted for by

the handling? A. Personally, naturally, I prefer to think that in their handling in some way that got in.

The Court: You think in the normal way of handling—in the normal ordinary handling of this, assuming now that they have the lead in, that is something they have added, but that the amount of lead they have got in, and the way they have got that arranged in their transportation tank, you think this quantity can be accounted for by that lead in the acid, and the iron that is there, added to what little will come in through commercial acid, or with a commercial acid, and the ordinary uses of it with ordinary pumps and tools? A. It just happens that I have not analyzed any commercial acid with copper content as high as we find in the truck acids, and I would hesitate to answer that question without having some basis for it.

The Court: Well, you see, I am interested right now, I am wondering whether I have got enough to make me suspicious that they—that is, whether you intend by this proof to create a suspicion—it is all right to do it, but there is something—put them on their proof—that they have added something, or whether the result of all of it, as a result of this you think I should draw the conclusion that it is all explained by the natural, ordinary use of this, coupled up with the plates of lead.

Mr. Owen: I think that that is all we contend, Your Honor. We do not contend that they have placed a chunk of copper, or any copper oxide or chloride in these tanks.

The Court: The rest of it then, all except that plate of lead, is just the ordinary way of handling this material.

Mr. Owen: No, it is not an ordinary way.

The Court: Well, that is what I want to know. Just what is it?

Mr. Owen: It is perfectly possible to handle this material in such a way that there will be no more copper and lead in the acid when it is put into the well than there is when it is in the storage tank.

The Court: You are talking now about not using the lead?

Mr. Owen: Not using the lead, and not using the steel tanks to transport it.

The Court: Well, all right. We will couple that up then. You claim that they should not use steel tanks with the lead. Is there anything else now that they have done?

Mr. Owen: If they use copper or bronze fittings, and the copper comes from those, they should not use those.

The Court: I am asking whether or not there is any claim that it is more than the ordinary use of copper—

Mr. Owen: With the equipment they use, no, it is no more than what you might naturally expect—

The Court: You claim that in order to avoid the infringement of this they have got to be careful to see to it that there is not any copper around in any of their pumps, or in any of their tools?

Mr. Owen: Yes, they have got to see to it that they do not add any of those inhibiting materials to their acids.

The Court: Well, I was getting at your contention about this.

Mr. Owen: If they use conventional methods of transporting their acid they won't have these impurities.

The Court: Well, now, I understood the witness, and he explained to me in the ordinary use of it you might get some of these things added, and there might be some copper quite naturally, and ordinarily, as I understand it, in some of the tools, and that there might be a little bit in the water. Not enough to account for anything much.

Mr. Lyon: Certainly they wouldn't allow us to use the Gravell patent, which is earlier than theirs.

The Court: Have you got anything, Doctor, here from which you can get any idea of how much of this is from the iron tank and the lead plate in the iron tank, and how much from all these other sources outside that have been referred to in the testimony? Is there any way at all? A. I haven't enough information to make any exact quantitative calculations, Your Honor. I regret that I haven't.

The Court: I see the difficulty of it. And these questions aren't in criticism of anybody at all. I understand

this, that you don't complain at all about the amount to be found in any of these storage tanks?

Mr. Wiles: No.

The Court: Then we won't worry about whether they got it in there through some pipes with brass on or not.

Mr. Wiles: No. It is in there.

The Court: Then, what you are talking about is entirely the increase that comes from the lead plates with the iron tank?

Mr. Wiles: Of course, we don't know exactly where it all comes from. It comes somewhere in their method of handling. There is no doubt about that. My own personal guess—we haven't samples of these tanks, but we do know there was a copper bearing steel which is rather extensively used for tankages, because it doesn't corrode as easily as straight steel, and I would make a guess that they probably have copper bearing steel tanks.

The Court: Do you complain about that?

Mr. Wiles: Yes, I don't complain about anything they do excepting putting inhibited acid down a well, and I don't care how they get it inhibited.

The Court: Some of this inhibition you are proving evidently it came in there perfectly naturally, and wouldn't be hardly possible to avoid. That is what we find in this storage tank, I take it.

Mr. Wiles: There is practically nothing there. The copper is way down.

The Court: There is some there?

Mr. Wiles: Traces, certainly.

The Court: And, as I understand it now, maybe I am wrong, it is because they increase that as a result of using those lead plates and an iron tank?

Mr. Wiles: Yes. Probably a copper bearing iron tank.

Q. (By Mr. Owen): You stated that you had made tests with different additions of copper to 15 per cent C. P. hydrochloric acid, and with different additions of lead and of iron. Will you state in a general way, before going into the details of your experiment, what those tests showed?

A. Those tests show that a very small amount of copper tended to inhibit the corrosive action of the acid against iron; and that as the amount of copper was increased, the corrosive action was decreased, of the acid.

Q. Within any limits? A. Yes. The greatest reduction in activity came with very small amounts of copper, one part to three or four parts per million is the greatest rate of decrease. Reaching three and a half parts of copper per million with copper alone with the C. P. acid, the per cent reduction of corrosiveness was 33 per cent, meaning that the acid was about 67 per cent as active as it would have been had the copper not been present.

Q. Now, let me understand you, doctor, was anything else added to that C. P. acid besides the 3.5 parts per million of copper, in this test that you have just referred to? A. No, nothing but the 3.5 parts per million of copper, and the corrosiveness of the acid was reduced 33 per cent.

Q. Now, can you give similar information regarding the addition of lead? A. 320 parts per million of lead gave a reduction of corrosiveness of 12 per cent without adding anything but the lead. It happens that the 320 parts per million of lead isn't far different from some of the lead we found in the acid samples. The extent of reduction in corrosiveness was 12%.

Q. How about the 3.5 parts per million of copper being about what you found in the defendant's treating acids? A. That was close to what we found in the defendant's treating acid.

Q. And have you carried the addition of copper beyond 3.5 parts per million? Did the inhibitive effect increase with the increase in proportion of copper? A. Not nearly at such a rate. For example, 5 parts per million of copper gave a reduction in corrosiveness of 37. 3.5 parts gave a reduction of 33; 10 parts per million, 38; 40 parts per million, 39.

Q. So that the 3.5 parts per million appears to be about the critical point of the increase in the reduction in corrosiveness due to the addition of copper, is that true?

A. It was a critical concentration. It gave nearly as high a reduction in corrosiveness as much greater concentrations.

Mr. Lyon: Did you say how much 1 part per million will do? Have you given that figure? A. I haven't given that figure. 1 part per million, 20% reduction in corrosiveness. I have no figure lower than one part per million of copper. I have figures higher than 40. I have figures up to 100 parts per million, which gave 40% reduction in corrosiveness. That was essentially the same as 40 parts per million.

Q. What were the results of your tests adding iron to the C. P. hydrochloric acid? A. We added both ferric iron and ferrous iron; adding ferric iron gave relatively little effect—as much as one-thousand parts per million gave an effect represented by per cent reduction in corrosiveness of 4%.

The Court: How can you say that iron is an inhibitor? If it was you couldn't use any hydrochloric acid down there at all. You will have iron down there and it will eat the iron. A. Your Honor, there is the possibility of iron existing in two forms—ferric and ferrous, setting up some type of reaction of the metals which might bring about some type of inhibition, but, as a matter of fact, we found there was exceedingly little inhibiting reaction of iron and the ferrous iron gave us no inhibition. As we have shown, the ferrous iron has apparently no inhibiting action; if it happens to be in the ferric form it might have a slight inhibiting action.

Q. (By Mr. Owen): In what form did you add the copper and the lead? A. We added these metals as chlorides. We added copper chloride and lead chloride to the C. P. acid.

The Court: This iron you found was not the free iron? A. No, in the form of a salt. In the form of iron chloride. Probably very nearly all of the iron that had been eaten off the tank was in the form of salt in the solution.

The Court: You see, I didn't have that idea about it. Now, the lead that you find, as I understand it, is because

of some sort of electrical plating action that started to go across to the iron walls somewhere and it got lost in the woods on the way over, and you found it floating around in there? A. Yes.

The Court: Has that got into lead oxide or lead something? A. Yes, lead chloride.

Mr. Owen: Just the same reaction that forms the iron, of course, that forms iron chloride. A. One forms iron chloride and the other lead chloride.

Mr. Wiles: The copper also is in the form of a salt in solution. A. Yes. Any copper present likewise would react with the hydrochloric acid and form a copper chloride, and that would be as a salt in solution.

Q. (By Mr. Owen): And I believe you testified that the copper and the lead and the iron which you added to the C. P. hydrochloric acid in making your tests was in the form of chlorides, copper chloride, lead chloride and iron chloride? A. They were in the form of chlorides before we added them to the pure acid, yes.

Mr. Lyon: Would the copper chloride tend to plate out on the wall of the tank under the battery action the same as the lead chloride? A. Essentially the same.

Mr. Lyon: Excuse me, Mr. Owen, but the witness started to tell us the effect of the addition of different amounts of lead. He gave the answer on copper, and started with lead, but he did not finish that. I should think that you would want him to finish that before he goes into the combinations.

The Witness: I referred to the concentration of 320 parts per million of lead, and stated that that much lead in the acid caused a reduction in corrosiveness of 12 per cent. Increasing amounts of lead produced relatively smaller effects. 620 parts of lead per million gave a per cent reduction in corrosiveness of 14 per cent, and 1000 parts per million gave a reduction in corrosiveness of 15 per cent.

Mr. Owen: Doctor, how did the most effective proportions of lead and copper in your tests, where you added those metals to the C. P. acid, compare with the amounts

of lead and copper chlorides which you found in the defendant's treating acids? A. Maximum,—close to maximum effects were reached when three and a half parts per million of copper to 320 parts per million of lead were taken together. Taken together in those proportions, they gave a reduction in corrosiveness of 38 per cent.

Q. Have you a table, Doctor, which shows the results of your tests, in which you added copper, lead and iron to C. P. hydrochloric acid? A. Yes, I have such data in my table XVIII.

(Table XVIII was offered and received as PX-166.)

The Court: When you take that combination of iron and copper, which you mentioned, in which you get your maximum of inhibition, as I understand it, do you explain that particular portion—does that advantage result from the fact that there is a coating on the thing that you want to inhibit the action on? Or does that all result from the salts that are in solution? It seems to me that there are two kinds of inhibition that bother me in a way. Is there any way that you can give me any idea as to their comparative force in producing this inhibited result? A. In a general way without going into detail of the mechanism I think it would be quite safe to state that the coating effect of copper in an amount represented by as little as 3½ parts per million would be sufficient to so coat the iron that the action of acid would be very greatly inhibited as we do find it; that there is sufficient copper there to form probably a complete molecular layer over the entire iron surface.

The Court: Do they call something that does that an inhibitor? A. They might, yes, because inhibition really refers to a cutting down of a process, and that would certainly tend to cut down the process considered as the whole.

The Court: There are,—or, aren't they recognized as two decidedly different things, one that would put a coating on something and fix it so it can't be equal to the acid like my Parker rustproof case, and another thing that you put something into it so that they will associate together side by side, and one won't eat up the other? It seems as though one is almost—A. (Interrupting): It is to a degree.

The Court: And this very thing I am talking about enters quite a little bit into the theory that later the plaintiff wants to talk to me about, about the using up of this acid and making it so it isn't desirable for its use in the rock. This very thing you and I are visiting about now gets right over into that problem, in my judgment. A. Of course, if the acid is inhibited and the inhibition consists in the deposition of metal, say copper on the iron, in such a way that the action ceases, why then there is no further need to worry about the action of the acid on the iron. We can say that the system is inhibited. But if the acid had contained none of this inhibitor, copper, to set up this action on the surface, why then the reaction could have gone on unhindered quite indefinitely.

Q. (Mr. Owen): What effect would that have upon the strength of the acid? A. The strength of the acid would decrease in that case.

Q. (Mr. Wiles): I want, if I may, to bring out the difference in the two theories you have spoken about. As I take it, one of the explanations is an unbroken uniform or continuous coating of copper, which keeps the acid off the steel. A. Right.

Q. And now, the other one is exemplified, as I understand it, if the coating is spotted, copper, just spots here and there on steel. Now, will you try to make clear the mechanism of how those spots of copper would prevent the acid from attacking the steel in the uncoated parts? A. Probably the most substantial explanation would be that one of the constituents might be absorbed on iron, and in that way tend to change the polarization of the system. For example, in some of the old style dry batteries that I think of, the old carbon cells in which the two electrodes were placed down in the electrolyte, current would flow for a short time and the current would stop, stop because the system had become polarized we say. The hydrogen could not escape. By adding some oxidizing agent to the system which would make possible the liberation of hydrogen, hydrogen would be liberated and the current would flow and continue. And

it is just about the same type of picture which is offered to account for the inhibiting action of metals such as iron—

Q. (Mr. Wiles interposing): Can't you put them on the blackboard so we can all see it? A. Well, suppose one has two electrodes, iron and lead, the electrolyte being hydrochloric acid, and we will assume fifteen per cent hydrochloric acid. Now, it is a little dangerous to speculate offhand which way the current is going to flow in that system. One might predict that the iron would go into solution and the current would flow that way, toward the lead electrode, and the iron would be deposited. That wouldn't be a bad speculation because from the table of the electromotive series one might expect that.

But when one actually carries the experiment out, he finds that it goes the other way, that the lead goes into solution and deposits on the iron. And so, if one has a coupling of that sort, it is true that a certain amount of the lead, as the lead from the plates in these tanks, will go into solution, pass through the acid, and the lead will be deposited on the surface of the iron.

Mr. Owen: Well, now, Doctor, when the lead goes into solution, what is it in the electrolyte? A. When the lead goes into solution, when it leaves the electrode in the electrolyte, it is lead chloride.

The Court: And if you were to stop that at any instant and analyze your solution you would find some of those that, as I have said before, got lost, whatever you want to say, they haven't yet become deposited and they have left the lead, isn't that right? A. That is right.

The Court: You would find some. A. In solution.

The Court: But the probability is you will find some iron in solution. A. And in the beginning there will be a certain amount of iron going into solution as well as lead, so both lead and iron would be found in the solution.

The Court: But that, for some reason, doesn't seem to be strong enough to swim clear across, and you don't find that coating on the lead, as I understand. A. That is right, Your Honor. It doesn't tend to come out forming a coating on the lead.

Mr. Owen: Now, Doctor, will you explain what the reaction is when the lead goes over and coats on the iron? A. If the lead goes over as lead chloride, when it comes in contact with the iron it deposits and forms metallic lead. It goes from the lead in solution to metallic lead.

Q. If the lead was coated on this iron electrode in the presence of hydrochloric acid what would occur? A. Of course, the current, flow of current would stop then, because, in effect, one would have two lead electrodes.

Q. Then, what would take place if both electrodes were either lead or covered with lead? What would take place? A. Well, the acid would tend to eat them off there.

Q. Before we leave this question, I just want to ask the Doctor if this field of electro-chemistry is not a different field from that in which you are devoting your time at the present time? A. At the present time, yes, that is correct.

Q. And you do not pose as an electrochemist of the last word, do you? A. At the present time, you mean? No.

The Court: I just want to thank you for having answered my questions.

Q. What you have done is to just answer the judge's questions to the best of your ability? A. I have, without attempting to refresh my mind on the points.

Mr. Wiles: I think there is one question that might be asked, which might help to clear this up, and that is, the Grebe and Sanford patent, Doctor, gives a specific illustration of arsenic as an inhibitor. Would you differentiate the mechanism of inhibition by arsenic from the mechanism of inhibition by copper, except as there is a difference in the degree of effectiveness?

Mr. Lyon: Is he speaking now of what distinction the patent makes, or outside of the patent?

Mr. Wiles: The patent does not mention copper.

Mr. Lyon: Oh, yes, it does. It defines an inhibitor in line 75, page 1, as a substance capable of inhibiting the attack of the acid upon metal surfaces, *e.g.* of iron or steel, copper, etc., with which it comes in contact.

Mr. Wiles: I am speaking of the inhibition of the acid against steel and copper on the one hand, and by arsenic on the other. Would you differentiate between the mechanisms, or are they the same, approximately the same, in your judgment? A. Well, broadly speaking, I should say that they are the same, broadly the same.

Q. (Mr. Owen): Will you refer to your Table XVIII, PX-166, and explain what it shows? A. In the table I have brought together the data obtained when small amounts of copper or of lead or of iron or of combinations of these metals were used, in studying the per cent reduction in corrosiveness. At the beginning of that table, the solutions are numbered, 1 to 7, consecutively, and there are indicated the results obtained when copper in amounts ranging from 1 part per million to 100 parts per million are used.

The Court: That is just your own arbitrary selection of these amounts? A. It is.

The Court: They are not samples or examples taken from any place, but you just fixed those up? A. I selected them to cover a sizeable range.

The Court: That is the way I understand it? A. And the percentage of reduction in corrosiveness runs from 20 to 40. The greatest effect comes with the increase in the small amounts of copper from 1 to 3½ p.p.m., the reduction stepping up from a 20 per cent reduction at 1 p.p.m. to a 33 per cent reduction at 3½ p.p.m. From 15 p.p.m. to 100 p.p.m. of copper the increase in corrosiveness is only 3 per cent.

Mr. Lyon: Didn't you find copper in the commercial acids that you analyzed? A. Yes, we did. From 24 hundredths parts per million to 37 hundredths parts per million, I believe.

The Court: You think I would be justified in reaching the conclusion that if you increased this beyond 100 parts per million of copper you would never get very much above 40? A. I wouldn't expect to, very much.

Q. (Mr. Owen): Well, now, Doctor, refer to the additions of lead and state what your tests show in that respect. A. Ten parts per million of lead added to the chemically

pure acid gave a per cent reduction in corrosiveness of 4. 40 parts gave a reduction of only 3%. I cannot account for that. It just happened that way. When you get up to 160 parts, you have a reduction of 6%. 320 p.p.m. gave 12 per cent reduction; 420 parts, 13 per cent reduction; 620 parts, 14 per cent reduction, and 1,000 parts, 15 per cent reduction. This was lead alone. No, copper.

Q. (Mr. Owen): So that the greatest percentage of increase there appears to have been from 160 to 320 parts per million; is that right? A. Yes; that is right.

The Court: And there isn't any theory that you know of to explain that? A. No.

The Court: It just does it? A. That is right.

Q. (Mr. Owen): How does 320 parts per million of lead compare with that found in the defendant's truck samples? A. Of the same order or magnitude.

Q. Well, now, go on to the next section of PX-166, referring to ferric iron and ferrous iron. A. Using different amounts of ferric iron varying from 300 parts per million to 1,000 parts per million, we found that the 300 parts per million gave a per cent reduction in corrosiveness of about one per cent; 440 parts, 3; 700 parts, 4; and 1,000 parts per million, approximately 4. In other words, the ferric iron had but very little effect in reducing the corrosive action. The ferrous iron in amounts from 300 parts per million to 1,000 parts per million had practically no effect in reducing the corrosiveness.

Q. And what is the difference between ferric iron and ferrous iron? A. Well, the ferric iron is one form of iron, a form of iron which, in solution, gives ions of a certain charge, and has a valence of 3, and the ferrous iron, in solution, has a somewhat different property. It is said to be di-valent, and has an electrical charge such that its valence is 2. The formula for ferric iron is $FeCl_3$, and for ferrous iron is $FeCl_2$.

The Court: I take it that there is no theory at all as to why 700 parts of the ferrous iron did give one per cent and the other didn't give anything even when you went up to 1,000? A. No, I have no explanation to offer of that.

The next section of the Table we used copper and lead. In the next section, the amount of copper was kept constant at 3½ parts per million, and the lead was varied from 10 to 1,000 parts per million. 3½ parts per million of copper plus 10 parts per million of lead gave a reduction in corrosiveness of 36 per cent. 3½ parts per million of copper and 40 parts per million of lead gave a reduction in corrosiveness of 38 per cent. 3½ parts per million of copper and 160 of lead, 38 per cent; 3½ of copper and 320 of lead, 38 per cent; 3½ of copper and 420 of lead, 38 per cent; 3½ of copper and 620 of lead, 40 per cent, and 3½ of copper and 1,000 of lead, 41 per cent.

Mr. Owen: Now, it appears, then, that with the amount of copper constant at 3.5 parts per million the inhibitive effect of the addition of lead was the same whether you added 40 parts per million of lead or up to 420 parts per million of lead. A. That is right.

Q. Is there any explanation for that? A. Well, no simple explanation other than the 40 parts per million of lead seems to be a sufficient amount of lead to give practically a maximum effect with the 3½ parts of copper.

Q. Then your table also shows the effect of small additions of ferric and ferrous iron to solutions containing 3.5 parts per million of copper. A. Yes, the addition of ferric iron gave but little effect. Adding 300 parts per million to the 3½ parts of copper gave a per cent reduction in corrosiveness of 33%, which was the same as the 3.5 parts per million of copper alone. 440 parts gave but 34%, 700 parts 33% and 1,000 parts 34%, which means that the ferric iron had practically no effect on increasing the reduction in corrosiveness of the copper.

Q. And what was the effect of adding small portions of ferrous iron with the same amount of copper? A. They showed essentially the same type of result as the ferric iron; adding from 300 parts per million up to 1,000 parts per million of copper in the acid gave values of 34, 34, 33 and 34 per cent, which mean that the ferric iron was practically without effect.

Q. In the next section of your table you have shown the effect of different combinations of copper and lead and of lead and iron with the lead kept constant at 420 parts per million. Please refer first to the portion showing combinations of copper and lead and give the results. A. When 1 part per million of copper was taken with these 420 parts per million of lead, about 30% reduction in corrosiveness was obtained. 3½ p.p.m. gave 38%, 5 parts 40%, 10 parts 41%, 40 parts 42%, 80 parts 42%, 100 parts 43%. So that by adding increasing amounts of copper to the solution containing also lead of a constant amount very nearly maximum effects were obtained with the 3½ parts per million of copper. From that point on increasing the amount of copper did not materially increase the per cent reduction in corrosiveness.

Q. Right in that connection, and in order to refresh the mind of the court, will you state approximately the average amount of copper and the average amount of lead found in the defendant's truck samples?

Mr. Lyon: Your Honor, it doesn't seem to me that these averages are anything but misleading. There is no such thing as an average infringement. We ought to have actual, if we are going to make determinations within two or three parts of a million, it seems to me we ought to have exact quantities compared. Averages just mix everything up in a scramble.

Mr. Owen: I will ask the witness to state the average amount of copper found in the Stella Wilcox samples, and the average amount found in the Zahn samples, and the average amount found in the Crawford samples, each separately? A. The average amount of copper found in the Stella Wilcox samples was 3.6 parts per million. The average amount found in the Zahn samples was 3.1 parts per million, and the average amount found in the Crawford samples was 4.8 parts per million. Now, taking an average of those three values: 3.6, 3.1, 4.8, would give 3.8.

Q. And, now, will you state the average amount of lead you found in the Stella Wilcox samples, and in the

Zahn samples, and in the Crawford samples, stating each separately? A. The average amount of lead in the Stella Wilcox samples was 417 parts per million, in Zahn 437 parts per million and in Crawford 53 parts per million.

Q. So that in Crawford the copper was higher and the lead was lower than in the other samples? A. It was.

Q. Now, take each of the truck samples separately, that is, the average of the Stella Wilcox, the average of the Crawford, and the average of the Zahn, for copper and lead content, and point out which of the samples in PX-166 comes the closest to each one of those? A. Well, for the copper and lead in the Stella Wilcox the values are 3.6 and 417; turning now to my table, 3.5 is the closest value as to that 3.6, and 420 is the closest value I have to the 417, which means the solution numbered 27.

Q. And, what is the reduction in corrosiveness shown on your test of that combination? A. The reduction in corrosiveness is 38 per cent.

Q. Now, do the same with reference to the Zahn. A. For the Zahn, the parts per million of copper 3.1; parts per million of lead 435; and the closest I would have to that, apparently, is my No. 27 solution, showing 38 per cent reduction in corrosiveness?

Q. And now as to the Crawford? A. The Crawford, 4.8 and 53. That will be hard to get, that combination. The nearest for the copper alone would be 5, which is solution 37. The nearest to the lead alone would be 40, which is my No. 9 and would give a reduction in corrosiveness of 3 per cent, and 5 parts per million for copper, which is my solution No. 3, gave a reduction in corrosiveness of 37.

Mr. Owen: Doctor, I believe that you had gotten down to solution No. 45 on your table No. 18 (PX-166). Will you take it up from that point? A. Solution No. 45 is one containing lead and ferric iron in this proportion: 420 parts per million of lead, 300 parts per million of ferric iron, which is not far from the ratio found in some of the samples, and gave a per cent reduction in corrosiveness of 12. It was noted that keeping the amount of lead constant

at 420 parts per million, and increasing the amount of ferric iron from 300 parts per million to 1000 parts per million, in steps of 300, 440, 700, and 1000, the per cent reduction in corrosiveness remained practically constant; in other words, increasing the amount of iron from 300 to 1000 parts per million had practically no effect on the reduction in corrosiveness. Referring to my solution No. 12 I find that 420 parts per million of lead alone gave a reduction in corrosiveness of 13 per cent. From that I should think it may be concluded that the addition of the iron had no effect on the solution.

Q. Now, taking up the next section, Solutions 49 to 52, where ferrous iron was added, what effect did that have? A. Well, the data show that when the lead remained constant at 420 parts per million, and the ferrous salt was increased from 300 to 1000 parts per million, the reduction in corrosiveness did not increase. As a matter of fact, the figures show a very slight decrease in reduction in corrosiveness.

The Court: Let me see if I have the right idea out of that, doctor; that there is probably so much of that ferrous iron in the acid—my reasoning would be different all the way—it finally got so much it has kept the acid busy with that added ferrous iron— A. (interposing) It might be speculative that the solution already contains so much iron when 1000 parts per million were present that it tended to retard a bit the normal action of more iron to go into solution.

The Court: Tell me what it was corroding, again? What did you have for it to corrode on? A. The iron test pieces, one inch, by 7/8 by 1/8, for sixteen hours.

The Court: Well, it didn't corrode so much when you put in more of your ferrous iron, when you put in 1000 as it did when you had 700 in? A. It happened it did not get so much.

Mr. Owen: Now, Doctor, take up the next section, beginning with solution 53 and explain what it shows, from 53 to 59 solutions. A. In that section the experiments were conducted by adding to the pure acid a given amount

of ferric iron—440 parts per million in each case, and the amount of copper was varied. The iron was kept constant in the different experiments and the copper was varied from one part per million up to 14 parts per million. In solution 53, containing 1 part per million of copper, 440 parts per million ferric iron the per cent in reduction of corrosiveness was 20. Solution 54 containing 3½ parts per million of copper, 440 of iron, 34.

Q. And how do those compare with the results obtained from those two amounts of copper without any iron? A. Very nearly the same. With the same amount of copper in the acid, 3½ parts per million, the per cent reduction in corrosiveness was 33%, and in this case with the added 440 parts of iron it was but 34%, showing the iron had very little effect.

Q. Am I justified in stating from these tests that the presence of either ferric chloride or ferrous chloride in 15% hydrochloric acid solution has no effect on the rate of corrosion when there is also present small amounts of copper? A. Well, apparently it has but very little if any effect.

Q. Now going to the last section of your table, you show combinations of copper, lead and ferric iron. Will you explain what those show? A. Well, in the first group of solutions from numbers 67 to 70 the copper and lead content is kept constant and the ferric iron content increased from 300 to 1000 parts per million, the copper and lead contents being 3.5 and 420 respectively. The effect of the increase in amount of ferric iron is at most but very slight for the results obtained are, for example, as follows: With 300 parts of ferric iron, the per cent reduction in corrosiveness, 39; with 440 parts, 40, with the 700 parts, 38; 1000 parts, 38; indicating that an increase in the amount of ferric iron when copper and lead are constant has but little effect and, if anything, gives a slightly lowered reduction in corrosiveness for the higher amounts of the iron.

The Court: Well, the adding of any of it doesn't seem to affect it, does it? I don't find much difference whether it is present or isn't present. A. The iron doesn't seem to make much difference.

Mr. Owen: Well, you refer to solution No. 27 in which the same amount of copper and lead were present as in solutions 67 and 70, and the reduction in corrosiveness is 38 per cent, which is substantially that of the same solutions with ferric iron added.

The Court: The adding of the iron to the copper and lead doesn't seem to do much of anything.

Mr. Owen: Apparently not. Apparently doesn't have much effect.

The Court: You have a little difference, but you can hardly run through experiments and not have, I suppose, a trifle difference.

Mr. Owen: Now, the next group from 71 to 77, does that show anything different, Doctor, that you wish to mention? A. In that case the copper was kept constant at 3½ parts per million and the ferric iron at 440 parts per million, while the lead was varied from 10 parts per million to 1,000 parts per million. I will refer to the results obtained in terms of the increasing amounts of lead. With 10 parts per million of lead present the reduction in corrosiveness was 34 per cent; with 40 parts, 37; 160 parts, 36; 320 parts, 37; 420 parts, 40; 620, 40; 1,000, 40. In other words, the maximum effects were obtained with about the 320 parts per million of lead, although as a matter of fact at 40 parts of lead it gave fully as high values. The maximum reduction in corrosiveness was obtained with 420 parts of lead, and increasing it from 420 to 1,000 didn't change the corrosive effect?

Q. What does the last section of these tests show? A. Why, in the last section are tests with ferric iron kept constant at 440 parts per million, the lead at 420 parts per million, and the copper varied from 1 part per million to 100 parts per million. The results show that with the 1 part per million of copper the reduction in corrosiveness was 30 per cent, with 3½ parts per million, 40 per cent; 5 parts per million, 39 per cent; 10 parts per million, 41 per cent; 40 parts per million, 40 per cent; 80 parts per million, 42 per cent; 100 parts per million, 42 per cent.

The Court: What does that show, the whole thing added together, more than that the copper from 1 part to a million up to copper at 5 parts to a million does the main trick, and the others don't do very much? A. I believe it does show that the greatest effect is obtained with the copper from 1 part to 5 parts per million, and that lead does contribute to the effect given by the copper somewhat.

The Court: Well, you haven't shown that the lead has done very much. 1 to 5 and I get clear up to 37. With 5 parts of copper alone I get 37. Now, where do you show anything—

Mr. Owen: (Interposing): I call your attention to solutions 23 to 29. That is the series which shows the effect of adding different amounts of lead to 3.5 copper.

The Court: But you don't get it higher than that, very much.

Mr. Owen: It shows at 10 parts of lead and 3.5 of copper, 36 per cent reduction in corrosiveness, and it goes up to 41 if you increase the lead up to 1,000.

The Court: Yes, but I know 3, 3½ parts of copper to 100 parts, you see, takes it up to 38. Well, 5 parts of copper all alone takes it up to 37. And three and a half parts take you to 33.

Mr. Owen: Yes, the copper is the effective agent, there is no question about that.

Q. (Mr. Owen): Doctor, you have at the bottom of this table one test numbered 85. What is the purpose of that? A. Well, that test shows the effect of the presence of ferrous iron. The copper is present in the amount of 3.5; the lead, 420, and the ferrous iron, 440. The results could be compared with those obtained in solution 75, using ferric iron. With ferric iron, the per cent reduction of corrosiveness was 40; using ferrous iron, 39. It indicates that it makes but little difference whether the iron present is ferrous iron or ferric iron. Neither of them have much effect in reducing corrosiveness.

In all of these tests on my Table 18 (PX-166) I used 50 c.c. of the hydrochloric acid solution, at 85 degrees Fahrenheit with no agitation of the solution.

I made other tests to show what effect agitation and increasing the percentage of the solution to the amount of exposed metal surface would have on the rate of corrosion. I made tests to cover both of these points, first, to determine the effect upon corrosion of agitating the solution during the test. In all of the results that I have reported so far, the solutions were not agitated; the metal strips were suspended in the solution, and the solution remained quiescent. I have prepared a table showing the results of those tests.

(The table was offered and received as PX-167.)

This table shows the results obtained when small pieces of strap iron of the size that we have just been discussing, the 1 inch by 7/8ths by 1/8th of strap iron, were tested for a period of 16 hours, at 85 degrees Fahrenheit, using as solutions the solutions given in the preceding table, my Table No. 18, Solution No. 2, for example in that table contained 15.1 per cent C. P. hydrochloric acid, 3½ p.p.m. of copper and no lead or iron and gave with no agitation, as reported in the other table, 33 per cent. With agitation the value appears in the column following as 44 per cent. So, agitating that particular solution stepped up the reduction in corrosiveness from 33 per cent to 44 per cent. And, then, similar tests were made with some of the other solutions. Solution No. 26 containing, in addition to the acid, 3.5 parts per million of copper and 320 parts per million—

Mr. Lyon: What kind of agitation did you employ? A. The agitation was brought about by placing my vessel containing a metal strip on the platform in a thermostat, and causing the platform to move back and forth, and the metal strip was supported by the small hole through the upper end which I referred to this morning with a glass hook. It was supported in such a way that the movement of the platform caused a swinging of the metal strip in the solution.

Mr. Lyon: Was the solution open to the atmosphere during the test? A. With a very small hole through the stopper which was placed over the vessel.

The Court: Was the liquid moved? A. The liquid

moved somewhat, but the pieces of metal swinging in the liquid would cause, anyhow—it moved by being on a moving shelf which was kept at a constant temperature.

The Court: And, it would all move at that rate except that the suspended iron was free to swing as a result of this motion? A. Was free to swing; that is right, Your Honor.

The Court: There was nothing to move the iron except that its momentum as compared with the momentum of the thing that you moved? A. The platform, that is right, Your Honor. And, a number of tests were made simultaneously on this same platform, the different vessels were set up with these strips of iron and as the platform moved they all were agitated to the same extent, so that all of the results that I report in this table would be obtained with practically the same effect.

The Court: The container was agitated enough to stir or move the liquid within it as to itself and in addition there was movement of the iron through this agitated liquid. A. Well, the 50 cubic centimeters which was the amount of liquid we had in the container, would fill the container perhaps to the extent of a couple of inches, or so the metal strip was suspended down in that liquid. Now, the movement of the strip certainly would stir the liquid in the container and agitation would stir it some, but not as much as the movement of the strip would stir it.

The Court: Then in addition to agitating the liquid it caused a movement of the liquid past the surfaces of the iron? A. It did, yes.

The Court: How rapid was that, again? Like a malted milk shaker? A. It didn't go that fast. Perhaps a round trip of the platform per second, something like that.

Mr. Owen: Now, will you go on with your explanation, Doctor, please? A. Using solution No. 26, which contained 3½ parts per million of copper, 320 parts per million of lead, no iron, gave without agitation a reduction in corrosiveness of 38%; with agitation, 48%. With the solution No. 30, the C. P. acid with the 3½ parts per million of copper, no lead, 300 parts per million of ferric iron, with no agitation gave

33% reduction in corrosiveness, and with agitation, 43%. The solution No. 34, with the C. P. acid 3.5 parts per million of copper, no lead, 300 parts per million of ferrous iron, with no agitation, 34% reduction in corrosiveness, and with agitation, 43%. Solution No. 68, in the C. P. acid, 3.5 parts per million copper, 420 of lead, 440 of ferric iron, it gave without agitation 40% reduction in corrosiveness, and with agitation 52%. Solution No. 85 contained besides the acid 3.5% parts per million of copper, 420 parts per million of lead, 440 parts per million ferrous iron, gave, without agitation, 39% and with agitation 50% reduction in corrosiveness.

Mr. Lyon: Doctor, these were percents of what? The same chemically pure? A. As I previously calculated. The percentages against blank acids.

Mr. Lyon: Were the blank acids agitated? A. Of a similar strength, yes.

Mr. Lyon: The blank chemically pure acids? A. Yes.

Mr. Lyon: You haven't any data here on that? A. I haven't data on that.

Mr. Lyon: Have you got it in your notes? A. I can get it for you. I can't say how soon. It is either here or at Ann Arbor.

Mr. Lyon: I would like to have it because you brought in the comparative data from which you calculated what was 100% in the case of the other tests, and I would like to see it in connection with these. A. I can furnish you with the data. If I don't have it typed, you will have to wait until I get it up here.

Mr. Lyon: Did you repeat any of your other work on agitation tests or just agitated these special samples made of C. P. acid with these particular parts of copper, lead and iron in them? A. As I recall, our tests are limited to these synthesized samples. I would want to leave the loophole to supply the information if by chance we were able to run the others. I don't recall that we did.

The Court: Have you any theory as to why agitation increased the reduction in corrosiveness? A. I think I probably have a theory which might account for it. It may

be that the inhibiting agent can more readily get to the metal if the solution is agitated so as to bring a greater volume of the solution in contact with the work per unit of time. There is but a limited amount of the agent in contact with the surface. The agent must diffuse through the solution to get to the surface. Now, perhaps after the agent is rather depleted near the surface, the motion of the plate out into new liquid would bring it in contact with more of that—

The Court (interposing): Stronger. A. (continuing) —agent, which is present in small amount.

Mr. Lyon: What I don't understand, Doctor, is whether the blanks which represent the one hundred per cent against which you tabulate these percentages here, whether when they were agitated that increased the amount of corrosion or decreased the amount of corrosion in the blanks? A. Well, I will attempt to get you that data.

Mr. Lyon: Doctor, don't you remember whether it did or did not corrode more when you agitate the blanks? You have all the measurements. A. Just for the moment I haven't those figures in mind. I can refer to my data here. (Refers to data.) Your Honor, I think I can answer the question now, and I can furnish the data, if necessary. It just happened that the blank sample showed very little change in the rate of reaction but it was the inhibited sample that was slowed down by the agitation.

Mr. Owen: Will you make your answer a little more complete? You mean that the blank showed little change in the rate of corrosion under agitation from that when it was not agitated? A. When it wasn't agitated.

The Court: What about that blank you are talking about? You are talking about this chemically pure solution. A. Yes. With a chemically pure solution it just happened that the amount of action, corrosiveness, was practically the same whether the solution was agitated, as I have described, or not.

Mr. Owen: Which solution are you speaking of now? A. With the C. P. Acid, and no added metal. We took one

sample and permitted the vessel to remain without agitation for a period of sixteen hours, and measured the loss in weight of that metal. And another sample the same weight, same body of liquid, same temperature, agitated as I have described, for sixteen hours, and it showed a slightly lesser loss of weight than the one which was not agitated: showing that agitation, in that particular case, decreased the corrosiveness.

The Court: That is what I expected, and I still feel this shows it. Maybe not.

Mr. Owen: I think it does.

The Court: That would be just in accordance with this. In other words, when you add it in then you didn't eat quite so much? A. That is right.

The Court: When it was not inhibited? A. When it was not inhibited it reacted at about the same rate whether agitated or not.

The Court: Then the only surprise to me is, when there was not an inhibitor in, it did not have the same effect. That is a surprise to me.

Mr. Owen: I think perhaps the doctor can explain that, at least theoretically.

The Court: All right.

Mr. Owen: What is your theory on that, Doctor? A. Well, the explanation as to why the movement of the liquid, or, why agitation tended to favor inhibition, the explanation I made a few moments ago is that the inhibiting agent in this is present in small amounts, and perhaps the solution immediately adjacent to the metal becomes but slightly depleted; while agitation may bring the plate in contact with fresh solution containing a sufficient amount of the inhibiting agent so the action is more rapid and pronounced, perhaps.

Q. Now, proceed with your explanation of your Table XIX (PX-167). A. We carried out another set of experiments using the same kind of metal, same temperature, length of time, and so forth, and using the same kind of solutions just described in the last set of tests. We used

a solution with a composition of our No. 2, for example, but instead of using 50 c.c. of the solution with agitation, we used 300 c.c. of solution.

The Court: But no more of the copper? A. The same amount of metal but instead of using 50 c.c. of the solution containing the 3½ parts per million of copper, for example in solution No. 2, we used 300 c.c. containing 3½ parts per million of copper.

The Court: You used six times as much solution but the same constituents of every kind? A. That is true, Your Honor.

The Court: And the only thing you didn't increase was the iron suspended. A. That is true.

Mr. Lyon: Your Honor, I would like to know if they figure the percentages against a new experiment with chemically pure acid with 300 c.c. or did they figure the 100% against this old blank they have used in here which only had 50 c.c. A. Naturally it was with the solution with the 300 c.c.

Mr. Lyon: You have no data on that? A. No.

Q. (Mr. Owen): Now, Doctor, continue. A. The results obtained in this case with the solution of C. P. acid containing 3½ parts per million of copper, no lead, no iron, gave a reduction in corrosiveness of 63% when agitated; a corresponding solution of 50 c.c. had given a reduction in corrosiveness of 44%. Passing on to solution No. 26 containing 3½ parts per million of copper, 320 parts per million of lead, it gave a reduction in corrosiveness with 300 c.c. of solution, agitated, of 63%. Solution No. 30 containing in addition to the acid 3½ parts per million of copper, no lead, 300 parts ferric iron, gave with agitation a reduction in corrosiveness of 64%. Solution No. 34 with 3½ parts per million of copper, no lead, 300 parts per million ferrous iron, gave a reduction in corrosiveness of 64%. Solution No. 68 in addition to the acid with 3½ parts per million of copper, 420 of lead, 440 ferric iron, gave 63%. Solution No. 85, in addition to the acid, 3½ parts per million of copper, 420 of lead, 440 ferrous iron, gave a reduction in corrosiveness of 65%.

The Court: What do you suppose the result would have been if you had another column of 300 c.c. solution with no agitation? A. I would expect it to behave somewhat as the 50 c.c. solution with no agitation, giving perhaps a slightly lesser reduction in corrosiveness, but that is only a guess.

The Court: You wouldn't expect to get a reduction in corrosiveness, would you, if you had taken 300 c.c.? I mean a reduction from the first column. Take that 33, first No. 2 in the first column.

Witness: Of less than that?

The Court: Where we got 33, it would just increase that to? A. I would expect it to be considerably more. It is unfortunate we have not had an opportunity to run such series. I explained at the beginning of my session on the stand that I had to be conservative of the samples I had and I didn't have enough of the samples to enable me to make runs using as much as 300 c.c. solution.

The Court: I would think if it went either way it would reduce that.

Q. (Mr. Owen): I wish, doctor, you would bring with you either tomorrow or next week the data you have showing your tests of the blanks corresponding with the first and third columns of figures in your Table 19. Is that clear to you? A. That would be the first column, the one above the 33 per cent, and the third column, the one above the 63 per cent.

Mr. Lyon: I would like 44, too.

Mr. Owen: All right. If you made blanks for the others beginning at 44 bring those, also.

The Witness: I will be glad to bring such data as we have, and will attempt to get that assembled and in order.

Mr. Owen: Doctor, at the session yesterday you were mildly criticized for having taken averages of averages in connection with your Tables 1, 2, 3 and 4, which are PX-154 to 157, inclusive, and I asked you if you would make up those averages, omitting any reference to averages of minor portions of the tests. Do you understand what I

mean? In other words, I want you to make up averages for those four charts or tables taking only the tests of the different truck acids. For instance, you have three Stella Wilcox No. 8 tests there. I want you to take those three figures under per cent loss in weight, and then I want you to go to the next sample, 12-B, Zahn, and take those three figures under per cent loss in weight, and so on down, and don't take any average of averages of the individual groups, but take one average of all of them. Take Table 1. The average would be of 2.02, 2.02, 1.98. Then you jump down to the third group, sample 12-B, and you take 1.80, 1.81, 1.81, and then you jump to the sample 5 of the Stella Wilcox and take 3.23, 3.30 and 3.22, and so on down, and when you get all those grouped take the average of them. Is that clear? A. I think I see what you mean now.

Mr. Owen: During yesterday's session, reference was made to the dates when the defendant purchased commercial hydrochloric acid, and placed it in its storage tanks, and counsel have agreed to stipulate that if Mr. J. J. Edwards were called to testify as a witness in this case, he would testify that he is manager of the Mt. Pleasant branch of the defendant in this case; and that he would further testify in accordance with the testimony given by him in his deposition taken in Mt. Pleasant on June 28, 1939, and I will read that portion of the deposition into this record. This is part of his direct examination.

(Reading): "Q. I asked you yesterday if you would bring data regarding the receipts of acid. Did you do that? A. Yes, sir. (Handing same to counsel).

"Q. What is it you have produced? A. Halliburton Oil Well Cementing Company monthly acid inventory."

This, of course, means the receipt of acid by the defendant company at its Mt. Pleasant station.

"Q. And what do these data sheets show? A. Show the district, the month ending ..., the year, and show the date raw acid was received, gallons of, Baume, the dates that raw acid was sold, the ticket number, gallons and Baume, the balance on hand, gallons and Baume.

"Q. Does it show the source of the acid? A. It shows from whom the raw acid was received and what was brought forward from the last report.

"Q. Will you please refer to data sheets you have produced and give the date on which each shipment of acid was received, the name and address of the company from whom it was received, the quantity received and the Baume? A. This does not list the address of the company from whom we received that.

"Q. Just give the name then, please? A. 4-23-38 we received from the Pennsylvania Salt Manufacturing Co., 3976 gallons 20 Baume acid (reading from the record).

"Q. Do you know the location of the plant from which that acid was shipped? A. I believe it was shipped from Wyandotte, Michigan. I am not positive of that. (Witness continuing): May 2nd, 1938, from Pennsylvania Salt Manufacturing Company, we received 3,914 gallons 20 Baume acid. May 3rd, 1938, from Pennsylvania Salt Manufacturing Company, we received 3,945 gallons 20 Baume acid. May 21st, 1938, from the General Chemical Company we received 6,075 gallons 20 Baume acid.

"Q. Do you know which General Chemical Company plant that was received from? A. I believe that came from Chicago.

"Q. And does that apply to all the later shipments from the General Chemical Company? A. I believe so. (Witness continuing): May 23rd, 1938, from the General Chemical Company we received 5,982 gallons of 20 Baume acid. June 15th, 1938, from the General Chemical Company we received 5,993 gallons of 20 Baume acid. June 15th, 1938, again we received from the General Chemical Company 7,824 gallons 20 Baume acid. July 24th, 1938, from the General Chemical Company we received 6,013 gallons 20 Baume acid."

And, interrupting his deposition there I will state that that appears to have been the last acid received prior to August 27th, 1938, when they received another carload from the General Chemical Company, and in the meantime the

Stella Wilcox treatments and the Zahn treatments were made. And, continuing the deposition:

"August 27th, 1938, from the General Chemical Company we received 5,938 gallons 20 Baume acid. August 17th, 1938, from the General Chemical Company we received 7,866 gallons 20 Baume acid. And that is the last."

This deposition, Your Honor, was given on June 28th, 1938.

And, continuing:

"Q. Will you state approximately the gallon capacity of your storage tanks? A. Our storage tanks approximately are of 10,000 gallon capacity each.

"Q. Do I understand correctly you have received no hydrochloric acid since October 17, 1938? A. To the best of my knowledge that is right. We don't indicate one here. (Witness looked through tickets). Our inventory doesn't indicate we have received any acid since that time.

"Q. What amount of acid did you have on hand after you received that last shipment? A. After receiving the shipment on October 17th this brought our storage up to 26,695 gallons, 20 Baume acid.

"Q. How is that acid delivered to you? A. By tank car, railroad tank cars.

"Q. And what is your practice regarding the unloading of the acid when the cars are placed on your siding? A. We removed the connections at the top of the dome of the tank car and put, I believe it is an inch and a half rubber discharge hose, from the dome through the opening into our storage tanks. There is another connection on the dome that is hooked up with a small rubber hose running from an air compressor located in our building next to the tanks. The acid is forced from the tank car into our storage tanks by an air compressor.

"Q. Do you customarily remove the acids within a few hours when the tank car is delivered on your siding? A. Customarily."

Now, that ends the portion of the deposition which I wish to read.

And, it is further stipulated that exhibits which were identified as Exhibits 1, 2 and 3 to the Edwards deposition may be received in evidence here as being photographs of the two storage tanks of the defendant company at Mt. Pleasant which have been referred to as the north and south storage tanks. There are two photographs of those tanks, Exhibit 1 shows them standing out very plainly, and Exhibit 2 is taken from a greater distance and a different position, and doesn't show them so clearly. Exhibit 3 to this deposition is a photograph of one of the defendant's truck trailers in which the acid is tranported from the Halliburton storage tanks to the wells where the treatments are given, and in which truck tanks this lead plate arrangement, which has been described, is secured.

The Court: Do you want any exhibit numbers in this case? Now the next exhibit number is PX-168.

(The photographs above referred to were thereupon marked PX-168.)

By Mr. Lyon:

Q. Doctor, you can produce the data showing the tests, the blanks of the chemically pure acid using 50 c.c. and 300 c.c. referred to in connection with your testimony as to Table No. XIX? A. We have that data with us, but it will take some time—a few minutes to find it. I can get it for you today.

Q. Can you compile it and give it to us by Tuesday morning? A. We can give it to you Tuesday morning.

Q. The next item, Doctor, did you not make similar experiments with the plaintiff's commercial inhibited acid? I think the court asked you about that, and I understood you were going to produce that data? A. I don't recall that I have such samples.

Q. Well, do you remember whether or not you had any specimens of acid to which one to five per cent of any of the inhibitors named in the Grebe & Sanford patent in suit had been added, and did you determine the percentage of inhibition by the same method you reported for the defendant's? A. Yes, with the—

Mr. Owen: (Interposing) I will say in that connection,

Your Honor, I have planned to offer proof of that kind this morning. We located it last night and are going to put it in.

Mr. Lyon: I would like to ask this question so we understand what this per cent inhibition means, Your Honor, in our studies of this matter over the week end. If the plaintiff's acid of the patent in suit containing one to five per cent of arsenic oxide shows that it is inhibited 99½ per cent as compared with the percentages that you have reported for the defendant's acid, that means, does it not, that the rate of corrosion of the defendant's acid is at least 100 times that of the plaintiff's own patented acid; is that not correct?

Mr. Owen: He is asking this witness to assume that the plaintiff's treating acid is 99.5 per cent inhibited, and if it is so inhibited, isn't this acid so many times more corrosive than the plaintiff's acid.

Mr. Lyon: I am trying to find out what this percentage means. What I am asking him is if the acid of the patent in suit, employing from 1 to 5 per cent arsenic oxide actually is inhibited 99½ per cent, if that, compared with the figure he has presented here as to the defendant's acid, does not mean that the defendant's acid is 100 times at least as corrosive as the acid of the patent in suit. I want to understand that. That will save us a lot of time.

The Court: I understand, for my purposes at least, that this is purely an arbitrary figure now.

Mr. Lyon: He has not produced a figure as to the plaintiff's acid.

Mr. Owen: The defendant's acid is not uniform. On some groups he gets a higher rate of inhibition than on others. If counsel wants to know the basis on which this computation may be made, I think he should take two arbitrary figures, one for theirs, and one for ours.

Mr. Lyon: I am willing that we should take for the defendant's acid, on the method of calculating that you have used in your tables, that the defendant's acid is inhibited 50 per cent, and that we should assume or take for

the plaintiff's acid, the acid of the patent in suit, that it is inhibited 99½ per cent. That means, does it not, that the defendant's acid is 100 times as corrosive as the plaintiff's? A. The question as asked, which is a hypothetical one, involves this, as I understand it, if the reduction in corrosiveness of one of the acids, referred to as the plaintiff's acid, was reduced to 99.5 per cent and if the corrosiveness of the defendant's acid was reduced in its corrosive action to 50 per cent, then it is quite obvious that the corrosive action of the defendant's acid is 100 times that of the plaintiff. That is correct.

Q. (Mr. Lyon): Now, were you not delivered samples for making corresponding tests from the Stella Wilcox well said to be taken on August 2nd?

Mr. Owen: That has been requested before, and the data is here, and I am going to examine the witness on it this morning.

The Court: Then they are going to answer that?

Mr. Lyon: Fine. Another point I would like to have you examine him on, if you intend to, if not I would like to arrange to get the data; did you examine the commercial acids and the defendant's well acid for the presence of anything except—and the defendant's tank acids, all three or any of them, for the presence of anything except copper, iron and lead? Did you examine them for arsenic or anything else? A. We did not for arsenic.

Q. Well, for anything else besides copper, lead and iron? A. As far as special analysis, no.

Q. Do you know whether commercial acid contains arsenic? If so, in what quantities? A. The ordinary commercial acids may contain traces, but not in any appreciable quantity, not in quantity to bring about inhibition to the extent that we have been discussing.

Q. Does it contain any arsenic ordinarily, commercial hydrochloric? A. We found none in making simple tests.

By Mr. Owen:

Q. Doctor, you were asked this morning whether you had tested the Grebe and Sanford process, using an arsenic

compound as inhibitor. I do not know whether counsel referred to the specific example of the patent or not—did you, Mr. Lyon?

Mr. Lyon: I would like to know what tests he made, using the arsenic chloride of between 1 and 5 per cent by weight in solution—the arsenic oxide.

By Mr. Owen: Did you make any tests using arsenic as the inhibitor in this Grebe and Sanford process? A. Yes, we did.

Q. What tests did you make in that connection? A. We made up a solution in accord with the stipulations of the patent taking the same relative quantities as are suggested in the patent, namely, for each five hundred gallons of 15 per cent acid—

Mr. Owen (Interposing): Let me read the statement from the patent. That is what the doctor is referring to. "For example, to 4500 pounds of a 15 per cent hydrochloric acid solution was added two gallons of arsenic acid solution containing 21 pounds of arsenic calculated at As_2O_5." Did you make up such a solution and test it? A. Yes. We made up a solution conforming exactly to those quantities, and tested it, and obtained a reduction in corrosiveness of 97 per cent.

Q. Now, do you have your notes on that test here? A. I haven't them in an assembled form. I simply have the data in some record I have here. Q. Read into the record what data you have. A. In my records here I have this notation. "Arsenic solution prepared according to the disclosure, Page 2, Line 74 and 78 of the Grebe-Sanford U. S. Patent No. 1877504, reduction in corrosiveness 97 per cent."

Q. Is that all you have here? A. That is all I happen to have here. I have other data available, but it is not with me.

Q. Will you bring it with you for the next session of the court? A. Yes.

Mr. Lyon: I would like to have it before, if we could have it Tuesday morning.

Mr. Owen: You mail a copy of it to defendant's counsel next Monday.

The Court: I am putting this 97 down as a percentage of inhibition. That is right, isn't it?

Mr. Owen: That is right. That is correct.

Mr. Owen: Doctor, how many gallons is 4500 pounds of 15 per cent hydrochloric acid solution? A. Apparently it is about 500 gallons.

Q. And, in your tests of this patent example what proportion, or what amounts of acid and of arsenic did you use, if you have the data here? A. We have the summary, but we can remember the volume of solution used was 50 cubic centimeters.

Q. Do you know how long you ran it? A. The same as the other experiments, as I recall; the 16 hours at a temperature of 85 degrees.

The Court: If the other witness discovers at any time that his memory is different, it will be perfectly all right with me to interrupt.

Mr. Owen: I will ask Dr. Cardwell to speak up without hesitation.

The Court: He nodded, and I wanted to give my approval to that rather than—sometimes, you know, I give a witness fits for coaching, but here it is all right.

Mr. Lyon: But just to clear this up at that point, did you repeat any tests with agitation or with 300 c.c.'s of acid corresponding to the tests you made with the defendant's samples on Table 19? A. I don't remember that we did.

Dr. Cardwell: We did not.

Mr. Owen: Now, Doctor, mention has been made on two or three occasions of the samples taken at the first treatment of the Stella Wilcox well on August 2nd, 1938, three days before the treatment of the same well concerning which you have testified. I will ask you if you made tests of the defendant's acid taken from the defendant's truck at the first treatment of the Stella Wilcox well on August 2nd, 1938? A. I believe that material is referred to in my notes as Samples No. 1 and No. 2, and I did make tests of such material.

Q. Will you refer to your notes and tell the court what tests you made and the results of those tests? A. Sample No. 1 gave a reduction in corrosiveness, with strap iron, of 82 per cent. Sample No. 2, with strap iron, gave a per cent reduction of corrosiveness of 84 per cent.

Q. Did you also test them with other irons? A. We did, with the National Supply Company iron, and the Oil Well Supply Company iron, and the Atha Supply Company iron.

Q. What were the results of those tests? A. With the National Supply Company iron, sample No. 1 gave a reduction in corrosiveness of 81 per cent. Sample No. 2 gave a reduction in corrosiveness of 78 per cent. With the Oil Well Supply Company iron—I shall read whole numbers here, I have the fractional parts of per cents which I shall omit, though,—sample No. 1, 73 per cent. Sample No. 2, 75 per cent. With the Atha Supply Company, sample No. 1, 88 per cent. Sample No. 2, 89 per cent reduction in corrosiveness.

Q. Did you analyze those samples, or either of them to see whether or not they contained copper, lead or iron, and, if so, what were the results? A. We did analyze each of them. Sample No. 1 contained 25 parts per million of copper; 270 parts per million of lead; and 480 parts per million of iron. Sample No. 2 contained 13 parts per million of copper; 250 parts per million of lead; and 480 parts per million of iron.

Q. I suppose the court would like to know, and I would like to have you state for the record, why you did not include the samples from this first Weber well, or, from this Weber treatment, in the tabulations which you have given showing the average corrosiveness of the defendant's treating acids on different pieces of iron? A. Probably,—there was one reason that we did not include that data in our first sets of tables. In the first place, the sample was quite different—I mean, the samples were quite different in appearance from the other samples; and they contained a surprisingly high percentage of copper; and, frankly, at

the time we were very puzzled, and we did not quite see how those samples fitted into the picture, we did not know what might be wrong. We figured that the other samples did represent representative samples, and showed uniformly throughout, but—well, it was for that reason, I think, that we failed to carry through samples 1 and 2 completely in our notes.

The Court: The samples of the acid are from— A. That is of the acid from the oil well.

Mr. Owen: Taken from the defendant's treatment at the Stella Wilcox well on August 2, 1938, three days before the other Stella Wilcox treatment of the same well.

The Court: Samples 1 and 2 were both taken from the same well and same transportation tank, at the same time?

Mr. Owen: Yes, Your Honor.

Mr. Owen: Doctor, did you find any other striking difference between this first Stella Wilcox sample and the other samples, that is, those taken from the second Stella Wilcox treatment, the Zahn and the Crawford treatments? A. Well, the one striking difference, the samples we received had a layer of oil on the samples, samples 1 and 2.

Q. How much oil, would you say? A. Oh, a very appreciable layer. I could tell by referring, probably, to original notes about the proportion of oil, but it was a very appreciable amount, a substantial layer of oil.

Mr. Owen: I will make an explanation at this point and support it by evidence so that Your Honor will keep up with the story. The evidence will show that when that first Stella Wilcox treatment was given the defendant first put in 500 gallons of acid into the well, and then the operator of the well asked him to make the treatment in four stages. There was 1000 gallons of acid. He asked him to make the treatment in four stages of 250 gallons each, so the defendant's truck man pumped back from the well 250 gallons of acid, pumped that back into the tank before these samples were taken, and, of course, in pumping it back into the tank it pumped a certain amount of oil along with it, and that was another reason why the Doctor

thought it would not be fair to rely upon those samples which show a very much higher percentage of inhibition than the ones on which he has relied.

Mr. Lyon: To complete that explanation, Mr. Owen, this Michigan oil contains mercaptans, and if you had some Michigan oil in this acid or long pipe it would inhibit the acid, would it not?

Mr. Owen: I will say in response to that, Mr. Lyon, that you are perfectly free to use uninhibited hydrochloric acid as you buy it commercially in the Michigan oil wells, and if you can get inhibition sufficient to protect those wells due to the presence of the oil and the slight inhibitors, slight amount of inhibitor, there may be in the commercial acid, we won't complain.

Mr. Lyon: I am not asking for that. Just to complete the explanation, you say that the Doctor rejected that sample because it had some oil in it. As a matter of fact, that oil would increase the percentage of inhibition.

Mr. Owen: It would, yes.

Mr. Lyon: That is the point I am getting at.

Mr. Owen: And, that is the fact in every Michigan treatment made by the defendant, that in addition to the inhibitors that are present in its acid when it is put into the well, they have the benefit of this inherent inhibitor which happens to be in the Michigan oil. But, our contention is that that natural inhibitor in the oil is not sufficient for the defendant, or anyone else, to get by with uninhibited acid, and they don't attempt to get by with it.

Mr. Owen: Now, Doctor, I will ask you if you have a table showing the different amounts of copper, lead and iron which you found in defendant's storage acids and also in defendant's truck acids, the samples of which you examined? Have you one of those? A. Yes; I have such a table.

Mr. Owen: This table will be offered as PX 169.

(The table above referred to was thereupon marked PX-169.)

Mr. Owen: I might state, Your Honor, this is merely

a convenient collection of this data so that you won't have to search through a dozen or more different exhibits to find it.

Q. (Mr. Owen): Now, doctor, will you explain what that exhibit shows? A. That exhibit shows the copper, lead and iron content contained in a thousand gallons of defendant's hydrochloric acid samples. The amounts are represented in terms of grams, and also there is represented on the chart the amounts expressed in terms of parts per million of the metal present in the solutions.

Q. In explaining that table, I suggest that you take up, first, the amount of copper in the storage samples and then the amounts of copper found in the truck samples. A. The amount of copper found in the storage acid sample N14B—that is with the storage acid diluted down to 14.5 acid to correspond to the truck sample acids—the amount of copper was 0.72 parts per million, or in each 1000 gallons of the acid solution the amount of copper was 3.1 grams. The same determination for the copper in the sample S14B, which is the south storage tank solution, diluted also to the same strength, was 0.69 parts per million or 3.0 grams in a thousand gallons. Now, the average copper content of the two storage tank acids was 3.05 grams per thousand gallons.

Q. Now, take up the corresponding truck acids. A. The corresponding truck acids are represented by Stella Wilcox sample in which the copper was present in 3.6 parts per million, or 15 grams per 1000 gallons, and in the Zahn acid sample of a corresponding strength, the copper was present 3.1 parts per million or 13 grams per thousand gallons.

Mr. Owen: Now, in this connection, I want to call Your Honor's attention to the fact that this Wilcox treatment and the Zahn treatment must have been made with the same storage acid because the data which I read in Mr. Edwards' deposition this morning indicates that no purchases of storage acid were made between July 24, 1938, and August 27, 1938.

Q. Now, you take up the lead item for those, please. A. The lead found in the storage acid sample N14B was 4.8 parts per million or 21 grams. In sample S14B 4 parts per million or 17 grams. The average of these two samples was 4.4 parts per million or 19 grams of lead in 1000 gallons of storage acid. In the corresponding truck acids, the Stella Wilcox sample had 417 parts per million or 1700 grams per 1000 gallons, and the Zahn acid 435 parts per million or 1800 grams of lead per thousand gallons.

Q. Now, take up the iron item. A. The iron content of the storage acid sample N14B, 13 parts per million or 56 grams; sample S14B 6 parts per million or 26 grams. The average of the two, 9.5 parts per million or 41 grams of iron per one thousand gallons of storage acid. While in the truck acids Stella Wilcox gave iron 473 parts per million or 1900 grams, and the Zahn well gave iron 380 parts per million, or 1500 grams per thousand gallons.

Mr. Owen: Now, before taking up the metal content of the N20B and S20B samples and the Crawford truck samples, I call attention to the fact that according to the testimony of Mr. Edwards, between the date when the Crawford well was treated and the date when the N-20 and S-20 samples were taken, there was one purchase of acid—7,866 gallons, from the General Chemical Company on October 17, 1938.

Q. Now, Doctor, take up these samples N20B and S20B, and the different metals in them, comparing them with the metals found in the Crawford sample? A. Storage acid sample N20B contained 0.17 parts per million of copper, or 0.75 grams. Sample S20B contained 0.26 parts per million, or 1.1 grams. The average of these two is 0.21 parts per million, or 0.92 grams.

The Court: Now, let me see, you are not claiming that these storage samples—you are not claiming that you have got a sample of the exact acid that they treated their well with?

Mr. Owen: No, Your Honor.

The Court: But this shows how their samples ran?

Mr. Owen: That is right.

The Court: Is it the thought that I will draw the conclusion that if that is the way they were running, that is the way they probably were when they treated the well?

Mr. Owen: Yes, Your Honor.

The Court: All right. It is not any exact proof, but it is substantial, in other words.

Mr. Owen: We have shown in the testimony read this morning, of Mr. Edwards, that they had I think six or eight purchases prior to the date of the Crawford treatment all made from the same source, the General Chemical Company.

The Witness: The analysis of the Crawford sample showed a copper content of 4.8 parts per million, or 20 grams. The corresponding data for the other metal constituents of the acids is, the storage acid sample N20B contained 2.6 parts per million of lead, or 11 grams. The sample S20B contained 7.3 parts per million of lead, or 32 grams of lead. Or an average of lead content in these two samples of 5.0 parts per million, or 21 grams. It was found that the lead in the Crawford sample of corresponding acid strength was 53 parts per million, or 220 grams in 1000 gallons.

The analysis for iron showed that in sample N20B, there were 7.0 parts per million or 30 grams. In sample S20B, 9.6 parts per million, or 42 grams. This gives an average iron content of these two samples of 8.3 parts per million, or 36 grams. The iron analysis of the Crawford sample showed 210 parts per million, or 860 grams per 1000 gallons.

Mr. Owen: Now, just to give a resume of this showing on this chart PX-169, Your Honor, it showed that the metals in the acid used in the treatment of the Stella Wilcox well were increased over those found in the storage samples taken at approximately the same time in the following proportions—the Stella Wilcox truck acid had approximately 400 per cent more copper than the storage

acid had; it had about 8,000 per cent more lead in the acid than the storage acid and 4,500 per cent more iron than the storage acid.

And the same data with reference to the Crawford well are that the truck acid contained approximately 2,000 per cent more copper than the storage acid contained; it contained approximately 1,000 per cent more lead than the storage acid; and approximately 2,300 per cent more iron than the storage acid. And those additions took place somewhere between the time when the storage acid was placed in the truck tank and the time when the treatments were made at the wells.

Now, yesterday we introduced quite a large number of charts which I know must have been more or less confusing and perhaps annoying to the court.

The Court: No; they helped me a lot.

Mr. Owen: But in order that the information with reference to the experiments made by Dr. Bartell, in which he added different proportions of metal in different combinations to fifteen per cent C. P. hydrochloric acid may be more accessible and intelligible, I have a chart which has accumulated that information and which I will offer as PX 170.

(The chart above referred to was thereupon marked PX-170.)

The Court: This shows corrosiveness and not inhibitiveness.

Mr. Owen: Well, it shows both. The dark line shows corrosiveness. The upper line is for 15.1 C. P. hydrochloric, which is shown for purposes of comparison to be one hundred per cent corrosive. And then going on down it shows the relative corrosiveness of these different solutions with the different additions, and at the end of the chart—

The Court (interposing): The black lines show corrosiveness?

Mr. Owen: The black line is corrosiveness and the figure at the end of the line is the percentage of reduction of corrosiveness.

The Court: Or inhibition.

Mr. Owen: Yes.

The Court: All right. The black line is the corrosiveness. That is what I first thought.

Mr. Owen: Now, will you explain this chart, Dr. Bartell? A. Black lines are placed on this chart on this scale to show the per cent corrosiveness of the different samples. Now, we have mentioned previously that with the C. P. acid the corrosiveness of that will always be taken as 100 per cent, and the C. P. acid is always used as a blank in making tests of the corrosiveness of other acid solutions. So that the first black line represents a hundred per cent corrosiveness of the C. P. acid. Now, the second line gives the corrosiveness of a solution of 15.1 per cent C. P. acid to which was added 440 parts per million of iron. The corrosiveness of that acid solution was 97 per cent that of the C. P. acid; or, the reduction in corrosiveness brought about by the 440 parts per million of iron in that acid was 3 per cent. These solutions to which I am referring on this chart are numbered. This is No. 16. That solution was referred to yesterday in my testimony in describing the corrosiveness of acid solutions to which have been added different amounts of metals.

Mr. Owen: That is PX-166, Your Honor, Table 18. In other words, the numbers 16, 11, and so forth, on this last chart just produced correspond with the solution numbers in the left-hand column of the chart in evidence as PX-166, Table 18.

The Witness: So, the first solution taken was No. 16 which I have just described, which showed a reduction in corrosiveness of 3 per cent.

The second test was that with solution No. 11 to which was added 320 parts per million of lead to the 15 per cent C. P. hydrochloric acid. That acid was 88 per cent as corrosive as the C. P. acid, or the reduction in corrosiveness was 12 per cent.

The next solution referred to is solution No. 2, to which had been added 3.5 parts per million of copper to

the 15.1 per cent C. P. hydrochloric acid. The corrosiveness of that acid is 67 per cent that of the C. P. acid, or the reduction in corrosiveness is 33 per cent.

The next solution tested was solution No. 30 to which was added 3½ parts per million of copper, plus 300 parts per million of iron. The reduction in corrosiveness in this case, again, was 33 per cent, showing that the 300 parts per million of iron added to the copper in this acid had practically no effect.

The next solution tested was solution No. 26. To the acid was added 3½ parts per million of copper, 320 parts per million of lead. The reduction in corrosiveness in this case was 38 per cent.

Solution No. 68, to which was added 3½ parts per million of copper, 420 parts per million of lead, 440 parts per million of iron—in that experiment the per cent reduction in corrosiveness was 40 per cent.

Now, in none of the samples mentioned so far was there any agitation. The solutions were of 50 c.c.'s in volume, and the metal pieces were as described yesterday, these small strips 1 inch by ⅞ths by ⅛th inch.

The next experiment represented on the chart is an experiment conducted by taking a solution the same as No. 2, containing 3½ parts per million of copper, but agitated. It is 50 c.c. again, and agitated as we described previously. In that case, the corrosiveness was much reduced; it was reduced by 44 per cent.

Q. How does that compare with the same solution in which there was no agitation? A. The solution which was not agitated gave a reduction in corrosiveness of but 33 per cent; so the agitation resulted in an increased reduction in corrosiveness.

Q. Just proceed with your experiments? A. Another experiment was performed, using the composition of solution No. 2, but using 300 cubic centimeters of that solution. Also, the solution was agitated during the test. Otherwise the conditions were the same, that is, the length of time and the temperature. In this case, the corrosiveness was much

less—the reduction of corrosiveness was greater, the reduction being 63 per cent.

Then another experiment was performed in which a solution indicated as solution No. 30 was used, 300 c.c. of that solution was used, and the solution was agitated. That solution contained 3½ parts per million of copper, 300 parts per million of iron. The reduction in corrosiveness shown in that test was 64 per cent.

Now, there is one more test illustrated on this chart, solution No. 68, which we have previously used with a smaller volume of solution, and with no agitation, and we get here 40 per cent reduction in corrosiveness. The solution was one containing 3.5 parts per million of copper, 400 parts per million of lead, and 440 parts per million of iron. Using 300 c.c. of this solution, and agitating it gave a reduction in corrosiveness of 63 per cent.

The Court: It is my understanding that there is no new information given in this chart over that previously given, but that you have assembled out of the information previously given certain data that you thought would be helpful to me and to every one, indicating the picture of this? A. Yes, Your Honor, I believe that is correct.

The Court: You have selected from your previous exhibits all of this—in other words, the preparation of this did not require anything special? A. No, no new data.

Mr. Owen: It is based on the data contained in the previous exhibits. I thought this would be more convenient for you.

The Court: Yes, it is.

Mr. Owen: I have just one more matter, Your Honor. Last evening I asked Dr. Bartell to make a new computation of averages from his Tables I, II, III and IV, PX-154 to 157, inclusive. Have you done that, doctor? A. I have, yes.

Q. Can you tell the court the results and how you arrived at them? A. It was suggested that averages be calculated by taking a summation of all the direct data, as loss in weight for the different samples of acid used with a

given piece of iron, taking the sum of all of those values, the per cent loss in weight; likewise to take the values obtained for corresponding blank acids. This was done. The summation of the per cent loss in weight for all of the oil well samples—I should say truck tank samples—were taken and then the summation of the corresponding blank samples weighed, so as to correspond in number to the truck tank samples, and then the total of these values were used and the reduction, per cent reduction in corrosiveness calculated from the summation of these two sets of values. By using that method, it was found that the average reduction in corrosiveness obtained with the metal strips of strap iron, as described in Table I, was 52 per cent.

Q. How did that compare with your previous figure made up in a different way? A. The values given yesterday, which was the average of the average values of the three oil well samples, was 53. So the values checked to within that extent, the calculation as suggested giving 52 and our method of calculation gives us 53, as the average of averages.

The Court: This latter one is really more accurate, is it not? A. No, Your Honor, I would not think it would be as justified, no.

The Court: Didn't you divide it by the—let's see now, you added all of the results and divided by the total here, the total number of experiments, is that it? A. We did, Your Honor, but it so happens that we had a larger number of samples for one of the oil wells than we did for the others, so, in my opinion, it was not quite as justified as the other method.

The Court: There was a larger—it was a truer average of your samples, but the way you had selected your samples, it made that unfair, doing it that way, and you take care of that unfairness by the first— A. (Interrupting): By the first method, yes.

The Court: In other words, if I was going to get the average weight of people in Detroit and Bay City, and I did not want to weigh them all, if I was going to go by samples,

I ought to select them relatively—if there are 100 times more in Detroit than there are in Bay City, I ought to pick 100 more samples from Detroit than I would in Bay City? A. That would be justified.

The Court: That is the theory that you used in taking care of this— A. (Interrupting): That is in effect the principle that I had in mind at first, since we had three samples from one well, and two samples from the other wells, and I took the average of the averages, yes.

(By Mr. Owen): Now, doing the same thing with your Table No. II, what was the result? A. Doing the same thing with Table No. II, the calculation made as suggested yesterday was 30 per cent; and the average of averages gave 31½ per cent.

Q. Now, will you take up Table No. III and Table No. IV? A. Table No. III by the newer calculation gave 38 per cent, and the value that I gave yesterday was 38.5 per cent. Table No. IV gave by the more recent method of calculation 50 per cent; and by the method reported yesterday 51.5 per cent.

Q. My notes that I made on my copies of these charts yesterday do not correspond with the figures that you have just given for your average of averages. I do not know where the discrepancy is, whether I made a mistake, and I will have to change all of these. A. Let me check back on the chart and my notes. (After checking) Well, I am not certain yesterday but that there was brought in a third method of calculation, that the average of the seven samples was taken on.

Mr. Owen: I will ask you do this, Doctor. During the recess I wish you would ascertain what the original figures were you gave for these averages, and then we will put them in the record. A. That would be very simple. If I were sure which set of figures were given, it is perfectly possible to make either calculation.

The Court: All right.

Mr. Lyon: Frankly, Your Honor, I may be able to arrive at a point here before one o'clock where we can agree

on what the issue is in infringement here, and dispose of any dispute as to the facts. I would like to do that because I would like to submit a clean cut issue to the court, if we could. That is what I am going to try to do. I have in mind what it ought to be, and if I can get an agreement on it, I would like to submit it. As I understand it, Your Honor, the plaintiff's charge of infringement in this case is based on increased amounts of copper and lead which they state they have found in the defendant's acid at the well as compared with the amounts that exist in the storage tank acid. Can we have an understanding to that effect?

Mr. Owen: The charge of infringement is based on the fact that the defendant's treating acids, which it uses in treating oil wells in this district to increase their productiveness, contain substantial portions of copper, lead and iron which they did not contain when those acids were purchased by the defendant, and as those acids stand in the defendant's storage tanks at Mt. Pleasant. And by "substantial amounts" I have reference to their effectiveness rather than to their quantity in grams or ounces.

Mr. Lyon: I think that answers my first question, Mr. Owen.

Mr. Owen: What we are interested in is the acid as it went into the well, and if that contained substantial amounts of inhibiting materials, that is what we claim to be an infringement, and I don't limit the charge of infringement to the portions of the inhibiting materials that were added or which accumulated in transit. I think we must take the acid as it is used in the wells and consider whether or not at that time it was inhibited acid within the meaning of this patent.

The Court: When it starts down?

Mr. Owen: When it starts down.

Mr. Lyon: As I understand it, those materials which you say are the added inhibitors are the copper, and the lead, and the iron which you find in the well acid which you didn't find in the tank acid. I just want to know if those are the inhibitors that you are charging to be an infringement.

Mr. Owen: I wouldn't limit myself in such a way as to exclude other inhibitors that might be present. Those are the ones our expert found and we have shown that the amounts in which they were found are in themselves quite effective, but if the acids contain other inhibitors—

The Court (interposing): You haven't shown anything about the results they obtained in the well.

Mr. Owen: All we can do at this time is to show what the acids were that went into the wells, and how much they were inhibited as compared with C. P. acid.

Mr. Lyon: Can I put it this way: Do you claim now or contend that there is any other added inhibitor in the defendant's well acid other than these added amounts of copper, lead and iron?

Mr. Owen: I don't think we are so much concerned with whether they were added or not, as we are with whether they were present or not when the acid was used.

The Court: As I understand the question, do you claim there was anything present except this copper, lead and iron?

Mr. Owen: Apparently there were some minor inhibitors present in small amounts.

The Court: That you claim? You had it to analyze all these months.

Mr. Owen: Yes.

The Court: Why don't you analyze it and claim it, if there is anything more than that copper and lead and iron that I have heard about that is in there? You have had the samples there.

Mr. Owen: Well, I don't see that the burden is on the plaintiff to show every different thing that might be in that acid that caused it to be inhibited. I think the question is whether or not the acid is inhibited, and not how it is inhibited or what causes it to be.

The Court: But I have no reason to think it is inhibited by any result obtained by the thing down in the well. The only reason I have got to think it is inhibited is because it has got copper, lead and iron in it. That is the only thing in the world that makes me think it is inhibited.

Mr. Owen: Well, you also have Dr. Bartell's tests, the results of his tests of the acid as it came from the defendant's truck tanks. Those were the first tests he made, and when he reached the conclusion that there were some things in that acid which caused it to be inhibited, then he made his analyses to find out what it was as far as he could, and he found that they did contain copper, lead and iron, and he has reported that data.

The Court: In other words, it is your contention that you could show it was inhibited and not bother what the cause of the inhibition was.

Mr. Owen: I think we could have done that.

The Court: You could put a piece of iron down in there and show it didn't eat it, and—

Mr. Owen (interposing): I think we could have done that, and it would be—the burden would then be on the defendants to show how the inhibitor got in there and what it was, and whether they were responsible.

The Court: As you claim the patent is so broad that it covers anything that inhibits.

Mr. Owen: That is true. Our patent is not limited to any specific type of inhibitor.

The Court: Or any particular type of metal.

Mr. Owen: No. No; that is true.

The Court: All right.

Mr. Lyon: I would like to go ahead.

Mr. Owen: It is confined to an inhibitor which will prevent corrosion of iron by hydrochloric acid.

The Court: He says he is satisfied with your answer.

CROSS EXAMINATION

Q. (By Mr. Lyon): Now, will you please refer to Exhibit 169, which is this summary of copper, lead and iron contained in grams per thousand gallons of defendant's hydrochloric acid samples, and convert those values into per cents so that we can compare them with the 1 to 5 per cent by weight called for in the specification of the patent in suit? A. Yes.

Q. I do not care about the storage acids. That will take too long. Just take the truck acids and convert them into per cent, so that I can compare them with the statement commencing at line 86, page 1 of the patent, reading "1 to 5 per cent thereof, based upon the weight of the solution." A. The values would be for the Stella Wilcox samples, 3.6 parts per million of copper, 0.00036 per cent. For the Zahn, 3.1 parts per million, would be 0.00031 per cent. For the lead in the Stella Wilcox, 0.04017 per cent. For the lead in the Zahn, 0.0435 per cent. For the iron in the Stella Wilcox, 0.0473 per cent. For the Zahn, 0.0380 per cent. And, the values for the Crawford would be; for copper, 0.00048 per cent; for the lead 0.0053 per cent; and for the iron, 0.0210 per cent.

Q. As I understand you, Dr. Bartell, you determined the per cent of inhibition for the specific formula appearing at page 2 of the patent in suit commencing at line 70 through to the end of the sentence on line 88, but in that test you employed no agitation; is that correct? A. That is correct.

Q. Now, it is reasonable to suppose, is it not, or you would expect that with agitation in that test you would get a higher percentage of inhibition than 97 per cent? A. We didn't perform the experiment. I would prefer not to speculate.

Q. With the defendant's samples where you had inhibitors present, you testified yesterday that agitation increased the percentage of inhibition. A. It did.

Q. Have you any reason to think that that wouldn't be true with the formula of the patent? A. I have no reason to base such an opinion.

Q. All right. Then the only thing we could do is compare the tests on the defendant's samples that had no agitation with the sample of the patent that had no agitation. I want you to tell me how many times as corrosive you found the defendant's samples to be than the specific sample of the patent formula, basing the comparison on the tests without agitation? A. It may take me a few moments to assemble the information.

Q. I wish you would, because that is the effect of your testimony and I want to understand your testimony today, if I can, and see if we can shorten this proceeding. Of course, I want you to confine yourself to experiments with the same kind of metal as you employed in making the experiment from the formula of the patent in suit. A. We haven't available the data with which I can make an exact calculation that you have asked for.

Q. Why not? A. I have not the data with me obtained with the arsenic sample that was referred to.

Q. You gave me a figure of 97 per cent. A. I did.

Q. Inhibited, didn't you? A. That was the reduction in corrosiveness, but I haven't the experimental data from which that was calculated.

Q. What is it that you don't know? A. I do not know the original amount of weight of the metal, nor the loss of weight, nor the per cent loss in weight.

Q. I don't need that. Do you know what type of metal that experiment was made on? I mean I don't need it for this particular question? A. It was made with a metal similar to that that we have stated in the other experiments.

Q. Which one? You have a lot of different metals? A. Strap iron. But I do not know which series.

Q. You don't know which series? A. Of strap iron we used in that particular test.

Q. Your strap iron figure is shown in Table No. I, is it not? A. Some of them are, yes.

Q. Well, now,—well, all of them on Table No. I, Series D and B, are the only two on there, aren't they? A. That is right.

Q. And they all use strap iron. Now, then, you found that the Stella Wilcox—the samples from the Stella Wilcox well were—what is the difference between Series D and Series B? A. As I explained previously the series came from different lots or pieces of strap iron.

Q. All right. Well, let us compare it with Series D, in the first place. You say that these tests on Table I had no agitation? A. That is right.

Q. All right. Now, we will compare your 97 per cent figure with your 47 per cent figure here, the first figure under the title, "Per Cent Reduction in Corrosion" in Series D. How many more times is defendant's acid as there shows corrosive than the patent sample which you say was 97 per cent inhibited? You divide 3 into 47, don't you? A. The corrosiveness of the plaintiff's sample would be represented by 3 into 53. The rate of corrosion of the one would be about 17 times that of the other.

Q. All right. Now, let us take the next value on that column 18, that is also 17, for all practical purposes, is it not? A. It would be close to that.

Q. 17 times. Now, let us go down to Series B on the Stella Wilcox well. On the basis of Series B how many more times corrosive is the defendant's well acid that was used on the Stella Wilcox well than the acid of the patent, the specific example from the patent you have given? A. Well, on that basis, it would be about 19.

Q. Sample 6 in Table I, the value 43 would also be approximately 19 times as corrosive? A. That would be 19 times, yes.

Q. And so would the average, then, without asking that. A. As a matter of fact, the one I gave before would be a little less than 19 in round numbers; it is close to 19.

Q. And so would the answer be from the sample from the Zahn well, which is value 42? A. In that neighborhood.

Mr. Lyon: Now, I would ask, Your Honor, is the plaintiff willing to concede, to stand on the results as shown from these tests, samples from the Stella Wilcox and the Zahn wells as typical and representing the results of the defendant's practice? And will it concede that the defendant's well acid is from 17 and 19 times as corrosive as an acid, or formula corresponding to that, commencing at line 74 through the sentence ending at line 79, on page 2 of the patent in suit?

Mr. Owen: We will not make such a concession for the reason that these tests made by Dr. Bartell are laboratory tests which were conducted for the purpose of showing how

much the defendant's acid corroded the iron in laboratory tests as against commercially pure acid. Now I think Your Honor appreciates that plaintiff is in rather a difficult situation here because we cannot go out and buy an oil well and bring it in here and have it acidized before the court and take that pipe before and after treatment to show the effect of the treatment. We will show, I will state to the court and counsel, by other witnesses, that we have done the next best thing—that we have conducted large scale laboratory tests, but instead of using 50 c.c. or 300 c.c. of acid solutions we have used about 200 gallons of solution. And we have run that solution through an oil well pipe. We have run a series of those tests, both with acids—hydrochloric acid to which these metals have been added in proportions found by Dr. Bartell—and acids which have been produced in a tank built in accordance with the description of defendant's truck tanks, which is in evidence. Those practical tests, as nearly practical tests as we are able to make, show a lower rate of corrosion for the synthetic acids made up to correspond as nearly as possible with the defendant's treating acids; they show a much lower rate of corrosion than resulted from Dr. Bartell's tests. So that I do not want to have counsel proceed or the court to proceed on the theory we are standing alone on Dr. Bartell's tests. Of course it is a simple matter of computation. Counsel doesn't need to fill the record with these computations. Your Honor can make them in your head. It isn't to show one acid is 19 times as corrosive as the other—

Mr. Lyon (Interrupting): I think it is the point.

Mr. Wiles: There is another element counsel has entirely overlooked, and I refer to that part of the specification which has our preferred example, which approaches, at least, one of the best of the inhibitors, but we name a considerable number of other inhibitors as being within the invention, and the use of those will show, and Your Honor will see that the plain intent was to cover inhibitors that are not as effective as the preferred one given, but which materially benefit conditions when you have the acid on iron.

Mr. Lyon: I will have something to say about that when we come to the argument. I am trying now to get the facts before the court.

Mr. Wiles: We are not going to stand on any specific example in the patent, where the patent names a considerable number that differ among themselves.

Mr. Lyon: Dr. Bartell, what per cent by weight of the solution of As_2O_5 is there in the specific example that I have referred to on page 2 of the patent in suit, commencing at line 74? A. (After figuring and conferring with Dr. Cardwell): The best that one can do with that is, of course, an approximate calculation, because to the 4500 pounds of the 15 per cent acid is added 2 gallons of arsenic acid, which changes the thing a little bit, but it would be in the neighborhood of about four tenths of one per cent.

Q. In other words, as far as the range of one to five per cent at line 86 on page 1 of the patent, that formula is a minimum quantity and not a maximum quantity; that is obvious, is it not? A. It is not obvious as to what is meant by the question. If the question simply is to ask whether .4 per cent is closer to 1 per cent than to 5 per cent, the answer is obvious.

Q. Yes. All right, now, referring to the tests with the Detroit company acid, which you stated was 15 per cent inhibited, in the case of strap iron without agitation, how many times as corrosive is that acid than the formula we have just referred to in the patent in suit commencing at line 73 on page 2? A. As I understand the question, the answer obviously is that if the Detroit acid is 15 per cent inhibited it is 85 per cent as active as the C. P. acid, and I understand that the solution referred to as covered by the description of the patent is the one which we reported as giving a reduction in corrosiveness of 97 per cent. Hence that acid would show a corrosiveness of 3 per cent that of the C. P. acid. So, on that basis, the acid showing 85 per cent corrosion would be about 28 times as active as one showing 3 per cent corrosion.

Q. Now, as I understand you, the plaintiff did not

furnish you with a specimen of its inhibited acid that it employs commercially under the patent in suit, and you have made no tests of any such specimen; is that correct? A. I have made no tests of the plaintiff's acid.

Q. Well, I show you a copy of the plaintiff's publication entitled, "The Acidizer" for April, 1939, "Importance of addition agents in acidizing," and call your attention to the table, "Comparative value of inhibitors," appearing on page 2, together with the statement "Per cent of effectiveness of several ordinary inhibitors for prevention of corrosion of steel as compared with 99 per cent results obtained from the use of Dowell's inhibitor." Now, on the basis that the plaintiff's acid of the patent in suit is inhibited to the extent of 99 per cent, then comparing that with the 47 per cent that you referred to in connection with the defendant's acid from the Zahn and Stella Wilcox wells, the defendant's acid is 53 times as corrosive as the plaintiff's acid, is that not correct? A. The answer to the question as to whether an acid which would show a corrosiveness effect of 53 per cent and another which would show an inhibition of 99, or a corrosiveness of 1 per cent, it is true that the one showing the 53 per cent corrosiveness would be 53 times as active.

Q. Now, you have produced Tables No. I, II, III, IV, VII, VIII, IX, XII, XIII, XIV, XV, XVI—no, or up to XIX, here, which appear to me to be all printed here, and all in order at present, but there seems to be missing Tables V, VI, IX, X, VII and XVIII. I want you to tell me what those other tables are? Do you have copies? A. No, I haven't.

Q. Well, you better tell us what they are first. Doctor, you have found those copies? A. I have found all but one of my tables.

Q. Tell us what they are. Tell us what missing table V is, and what missing table VI is, and so forth? A. I will, as far as I am able to here. Missing table V was simply a summarizing table, giving a summary of the per cent reduction in corrosiveness of table I, II, III, and IV;

and it contained that summary of results with the data obtained with the samples from the three—the truck acids from the three wells, and with the four metal pipes. It was simply a summarizing table.

Q. What about table No. VI? A. Table No. VI was a table with but four entries, and that table gave the percentage composition of the concentrated hydrochloric acid found in the storage tanks, samples N-14-B, N-20-B and S-14-B and S-20-B, together with the average of those concentrations.

Q. What about Table No. IX? A. Table No. IX is another summarizing table. It gives a summary in the reduction of corrosiveness, tests made with the storage tank acids, together with the calculation of the average reduction of corrosiveness for those samples.

Q. And table No. X? A. I am uncertain about my table No. X. The position I have here for No. X is the table I presented with the percentage of reduction in corrosiveness of five commercial hydrochloric acids, the values, the figures that I read into the testimony the other day; but I am not certain that that was the original No. X. In fact, I doubt it. I would like to check back on that.

Q. Now, what about No. XVII? A. XVII was a table I had compiled giving data of the analysis that we made of the samples of Mt. Pleasant water, taken on different dates, and it gave the copper analysis of the water on those six different dates.

Q. Now as I understand it we now have before us all the tests that you made?

The Court: No. X, he doesn't know.

Mr. Lyon: He says he thinks it is the percentage of inhibition of commercial hydrochloric acid. A. I am quite certain it had to do with inhibition. I would like the opportunity to place the proper table there if I can locate it. It apparently hasn't been in my notes since I have been on the stand. I thought my tables were complete when I came on the stand.

Q. When we get No. X now, we will have had reported

here the results of all the work you did on this subject, is that correct? A. Oh, I wouldn't say that is entirely correct. I certainly have done some work that may or may not show up in these particular tables. That would be a pretty broad statement to make.

Q. Have you done any experiments on any of these subjects of any significance in connection with the matters that you have reported here which haven't been presented? A. I believe I am correct in stating that this would represent all of the significant work. I believe it would. I say that with reservation. I may have overlooked something but if I have, I don't recall what it would be, with the possible exception of what may appear on that table X.

Q. Now, you did not determine what effect agitation would have on increasing the percentage of inhibition which you reported for the commercial acids, did you? Commercial raw acids? A. No, we did not have that data.

Q. You didn't determine what effect conducting the experiment with 300 c.c. of acid instead of 50 c.c. of acid would have on the percentages of inhibition that you reported to the commercial raw acids, did you? A. No, I don't think I did.

Q. Your answers to those two questions would be the same as to the samples of defendant's storage acids? A. That is true of both the defendant's storage acids and tank acids.

Q. Now, Doctor, can you tell us the date you did the work which is reflected on the table No. I, the date of the experiment? I wish you would take each one of these tables and give us the date the work was done by you and your associate. A. That is asking for a pretty large order. We will be glad to do it. I couldn't do it without referring to my notes.

Q. Has any of this work been done recently? Any of the work reported in your testimony? A. Yes. Some.

Q. When was the most recent work? A. Work I reported on the agitation.

Q. When was that done? A. Oh, that was done within recent weeks.

Q. How long ago? A. I would have to check to give you the exact dates. Some of it within, I believe, the last three weeks.

Q. Now, these tests you made with the samples from the Crawford well, and the amount of or the per cent of inhibition which you report is more than could be the result of the presence of the copper and lead and iron which you have reported for those samples; isn't that correct? A. I don't know that I have made an analysis of the result from that standpoint.

Q. Well, now, wait a minute. You put a table in here showing that after you got up to a certain point that added amounts of copper or added amounts of lead did not materially affect or increase the inhibition? A. That was with chemically pure acid, yes.

Q. You didn't make these various comparisons as against commercial acids? You made them as against chemically pure acid? A. We used chemically pure acid; yes.

Q. Well, now, you don't think that those results are valid for what the differences in the amount of inhibition and the percentage of inhibition there will be between commercial acids and inhibited acids, as distinguished from chemically pure acid? A. The commercial acid may contain certain impurities which might have a somewhat different effect upon the tests.

Q. Well, can you definitely state in the case of these Zahn and Stella Wilcox samples what part of the percentage of inhibition which you report is in excess of the inhibition that was had by the storage acids from which the well acids or tank acids were derived? Can you state that definitely? A. My answer to that is simply reference to the testimony I have given, obtaining or taking samples of the storage acid, actually making tests with that acid, then actually making tests with the Zahn well acids, gives the comparison to be obtained between the two.

Q. How many tests did you make with the samples of the storage acid to determine the per cent inhibition of

that storage acid? A. Well, we made at least one in every case. Not always as many as in the other case, for the simple reason that we did not have the volume of acid to work with.

Q. I notice, Doctor, that in some of these cases you compare the results of one test with an average of the results of three or four tests? A. Yes.

Q. Now, that is not valid; if the result of the one test is approximately the result of one of the series of tests that you are going to average—that is true, is it not? I will try to pick one out here. Let us look at PX-159. A. Yes, sir.

Q. You report as the average per cent loss in weight, with six trials, with commercially pure hydrochloric acid, a value of 2.53, do you not? A. With the chemically pure hydrochloric acid, yes; we used the data obtained with six different tests.

Q. And one of those individual tests has a value of 2.44, has it not? A. It has, per cent loss in weight, yes, sir.

Q. Will you look at the next item above it, that individual test you made on Sample S-14-B has a value of 2.43, has it not? A. It has, yes, sir.

Q. You report that the relation between the sample S-14-B and the chemically pure hydrochloric acid shows a value of what? Of 4.0, do you not? A. That is right, yes, sir.

Q. Well, there is no such difference between 2.43 and 2.44, is there? A. No, but it must be pointed out that all of the data we had for the S-14-B sample gave a value of 2.43, while we were able to take the average of the number of tests made with the chemically pure acid, and the average value in that case was 2.53.

Q. How do you know that a single experiment that reports a value of 2.43 is not in a relation corresponding to the value of 2.44, one of the tests with the chemically pure acid? A. Throughout we have taken the best data that we could obtain under the conditions, and have made the calculations accordingly. We have presented the data,

that this represents the results with one sample, and we feel justified to use the figures in the calculation.

Q. Now, I want to know within what per cent of accuracy we can accept this work, if it is based on that kind of relations. If you are going to take one value for one acid and six values for another, and derive a percentage, you can't say that is accurate work. A. Our six values certainly shows we did no choosing there to obtain the best values.

Q. I am not accusing you of anything. A. And all we can say about the other is that it was the best value we could obtain under the conditions with the amount of solution we had.

Q. Isn't it just as logical to say that if you could find a sample of the S-14-B acid test that came out 2.14 and a test with the C. P. acid 2.44 that those are the comparisons that should be made rather than add five more of one and none of the other in the form of tests? A. That would not be my opinion. I see no reason why one with a series of data should pick from that series of data some one value that just happened to fit a situation.

Q. In many instances in this work you have used,—you have compared the value of an individual experiment for one material with an average of the values of chemically pure hydrochloric acid tests? A. Not in many places in our work, no.

Q. If you are going to compare one average with another you should have the same number of tests in each of the series that you are averaging, should you not? A. It is well to when one can.

Q. Well, what about on this same sheet, PX-159; you averaged two tests of sample N-20, two tests of sample S-20, and how many tests of hydrochloric acid? A. Well, it just happens there that nine are reported. It happened that many values were available.

Q. Now, in the results that you depend on for your reports and for your calculations are loss in weight per grams of the samples of metal that were suspended in the

various acid solutions, is that correct? A. Loss in weight calculated in grams, yes.

Q. That means you weighed the specimens of metal before and after the experiments? A. That is right.

Q. And if we attribute this reduction in corrosiveness to the action of copper and lead on the assumption that you made yesterday that copper and lead in its inhibiting action would, to some extent, plate out or form a protective coating on the specimen in the metal, would it not? A. Some of the copper and probably some of the lead would tend to deposit on the metal.

Q. Whatever amount of such copper or lead did so deposit would increase the weight of the sample when you weighed it, and increase the apparent reduction in corrosiveness, would it not? Unless you corrected for it? A. But the difference in weight due to such a coating would be exceedingly slight for a given piece of metal, such as the size we used.

Q. Oh, well, did you measure it to determine how much it would be and make a correction for it? A. I haven't made any calculation.

Q. Did you make any correction for it? A. We made no correction for it.

Q. Well, we are dealing here with very small quantities, are we not, in these tests? A. We did go so far as to make this calculation, if I may amplify the answer, that weighing out to the fourth place as we did, the amount of copper or lead would not be detected.

Q. How do you know? A. Well, we know that from the amount of copper we had in solution, for example, and the change in concentration that might have occurred in the solution, that there is not enough copper plating out to be weighable on a piece of that size.

The Court: That is, I thought, if I got the meat of your question, the deposit of lead on there would be just as important in the matter as a deposit of copper.

Mr. Lyon: That is correct.

The Court: I understood the answer to say that the amount of copper would be very small. What about the

lead? A. Such lead as might deposit would not be detected in the weighing to the accuracy of these weights.

Q. How do you know if you haven't tried? A. Well, that is simple enough to make a calculation. Do you have any evidence on that (addressing Dr. Cardwell)?

Dr. Cardwell: You know how much copper there is in the solution, and we know that is beyond the fourth place.

A. Yes; even the total amount there.

Dr. Cardwell: If you plated it all you couldn't weigh it.

Mr. Lyon: I believe you attribute or are willing to attribute the greater reduction in per cent—per cent reduction in corrosiveness of the samples from the Stella Wilcox on August 2nd to the presence of oil in the samples that were delivered to you; is that correct? A. Those are the samples I mentioned this morning?

Q. Yes, I think so, Doctor? A. No, I am not ready to make that admission. I do not know for certain why the bigger difference in the two samples occurred.

Q. Did you analyze that material to see or make any test to determine if it was contaminated with an oil and whether that oil had any inhibiting effect on the acid? A. I don't recall the tests I may have made on that at the time. I don't recall that we had data on that. I do remember that at the time we stopped work temporarily with that sample, and whether we went back to it I don't recall.

Q. Did you make any tests on samples from the Zahn and the Stella Wilcox wells, the other samples, or from the Crawford well, to determine whether or not they were contaminated in any way or with any oil? A. I don't recall that we did.

Q. Based on all results of your work and all that you know about the subject, in your opinion did the well samples from the Stella Wilcox well which you refer to as your sample No. 8, or the well samples from the Zahn well, which you refer to as your Sample 12B, or your sample 5 from the Stella Wilcox well, your sample 6 from the Stella Wilcox well, or your sample 12 from the Zahn well, contain any inhibitor other than the amounts of copper, lead and iron

which you have reported that you didn't find in the storage samples N14B and S14B, N20B and S20B? A. I wouldn't be able to answer that question without very careful study of the figures.

Q. Have you made such a study? A. I don't know that I have made a study that would answer specifically the question you have asked. The question is long enough so I am just a little bit uncertain as to the entire scope of the question.

Mr. Lyon: Well, let's leave that question unanswered until we resume here, and in the meantime you may be able to prepare the answer to it if you will.

Q. The per cent of reduction in corrosiveness you reported for the Crawford well is higher than you could account for because of the presence of the amounts of copper, lead and iron, is that correct? A. I believe it was.

Q. But you have no suggestion as to what it was in those samples that produced that greater percentage reduction in corrosiveness? A. Well, apparently, there is some constituent present other than the metals that gives the greater percentage reduction in corrosiveness.

Q. Did you attempt to determine what that is? A. And I have made no attempt to determine what that might be.

The Court: Well, is oil an inhibitor? A. It has been suggested here, I think by counsel for the defense, that oils do contain certain sulphurous compounds that might have that effect, and, if that is true, I would not want to rule out the possibility of such a constituent being present in the oil.

The Court: That is, oil as oil? A. Oil as oil, but the pure oil I would not expect to have an inhibiting effect.

Mr. Lyon: I call your attention to line 3, page 2 of the patent in suit, Grebe and Sanford, 1,877,504, one of the inhibitors there specifically mentioned is mercaptans, is it not? A. Yes, sir, it does.

Q. That is a sulphur compound? A. That is a sulphur compound, yes, sir.

Q. It is well known that Michigan oils are especially rich, if you want to use the word "rich," in mercaptans? A. I would not say that it is well known, because I did not happen to know it myself, and if that is true I really should have known it, but they may contain mercaptans.

Q. Mercaptans have a very distinctive odor, do they not? A. They do.

Q. Do you know whether they have a pretty distinctive odor that corresponds to the odor of mercaptans? A. I know that some of the oils have a reasonably pungent odor, but I have never happened to associate it with mercaptans.

Mr. Owen:- The witness has found Table X, which was referred to on Saturday, and which relates to the tests that he made with other inhibitors mentioned in the Grebe and Sanford patent. I think the mixup on Saturday came about by reason of the fact that his Table X was confined to his use of 1 per cent of the inhibitor; and I learned that he had made tests with higher proportions, and I wanted him to revise the table, so as to include the higher proportions.

We have both tables here which I will ask the witness to produce, first the original one, and then the revised table.

Mr. Owen: The witness has produced his original Table X, which I will offer as PX-171.

(The table above referred to was thereupon marked PX-171.)

Mr. Owen: Will you explain this table PX-171? A. Table PX-171 contains results on percentage reduction in corrosiveness when some of the materials referred to in the Grebe-Sanford patent were used. The results were obtained using strap iron, of pieces the same size as have previously been described, 1 by 7/8ths by 1/16th inches, in acid solutions of 50 cubic centimeters, and the tests were run for the period of 16 hours. The materials reported in that table are a saturated solution of acridine in 15.1 per cent hydrochloric acid, which gave a reduction in corrosiveness of 41 per cent. 1 per cent solution of aniline in 15.1 per cent

hydrochloric acid gave a reduction in corrosiveness of 34 per cent. A 1 per cent solution of pyridine in 15.1 per cent hydrochloric acid gave a reduction in corrosiveness of 47 per cent. A 1 per cent solution of quinoline with the same concentration of acid gave a reduction in corrosiveness of 84 per cent.

Q. Now, those tests were without agitation, as I understand. A. Those tests were without agitation.

Q. Now, did you make tests of any of these inhibitors using more than the amounts you used in the tests shown in Table X. A. I did.

Q. Will you state what those tests showed, and whether or not you made them at the same time you made the tests in Table X? A. The solutions of three and five per cent which were run were run a few days later than with one per cent solution.

Q. What were the dates? A. Let's see. That is about a year ago.

Q. Now, will you state the results of your tests using higher proportions of inhibitors? A. Using three per cent aniline—

The Court (interposing): Have you got those in a table? A. I have not, Your Honor. I have them simply in my own notes.

Mr. Owen: In the tests shown in this PX-171, the witness used saturated solutions in the case of acridine and a one per cent solution in the case of aniline. That is, he added one per cent of aniline to the fifteen per cent hydrochloric acid, so that the solution contained, the entire solution contained one per cent of aniline and ninety-nine per cent of the acid. Now, the new tests that I am going to ask him about were the same as those shown in the exhibit except that instead of using one per cent of aniline he used three per cent, and I believe also one with five per cent, and the same is true with respect to the pyridine and the quinoline. He did not change the hyrochloric acid solution strength, but he did increase the percentage of inhibitor placed in that solution. Is that clear?

The Court: Yes.

Mr. Owen: Now, will you go on with your answer, Doctor? A. The three per cent solution of aniline in the hydrochloric acid gave a reduction in corrosiveness of 60 per cent.

Mr. Owen: I think I will ask the Doctor to re-tabulate this exhibit PX-171 and to add these.

The Court: If there is going to be only a couple, and nobody has objection, I will just add it right down below in pencil.

Mr. Owen: All right.

The Court: Three per cent. That is what?

Mr. Owen: Reduction in corrosiveness of 60 per cent.

Q. Then with 5% of aniline, what was the result? A. The value was 67% reduction in corrosiveness.

Q. Now, as to the pyridine, did you make other tests with that? A. I did. With the 3% solution of pyridine the reduction in corrosiveness was 60%. And with the 5% solution the reduction in corrosiveness was 65%.

Q. Now as to the quinoline? A. With the quinoline, the 3% solution gave a reduction in corrosiveness of 84%, and the 5% solution a reduction in corrosiveness of 84%. The different concentrations of quinoline gave practically the same value in reduction of corrosiveness.

Q. Referring now to the five commercial acids which you purchased and tested, do you recall when you purchased those acids? A. It was approximately in June of '39. It was close to June of '39.

Q. And what did you order? A. I ordered from each of the companies which have been mentioned, a gallon of their commercial acid.

Mr. Owen: Now, during Saturday's session the court asked for the dates of the different samples.

The Court: If I remember my own mind—I recognized it was all in the record—what I was suggesting was that somebody that had time make a little tabulation of something that I could put my eyes on. You talked about analyzing these different things. Something I could put my eyes on so I can place them properly in the picture.

Mr. Owen: We will be glad to do that.

The Court: All right.

Mr. Owen: I think it might be convenient if we prepared a tabulation showing the dates when the defendant replenished its storage tanks and the dates when these well treatments were made, and the dates when the storage samples were taken.

The Court: And the samples taken out of the transportation tank.

Mr. Owen: Yes. We will do that.

The Court: I dare say it is in the record that we had in mind to get. This other was just an added thought. Now, you have got it all in the record, but I doubt if any of you could exhibit to me right now, although in the record, and if you could I would have it this afternoon if I wanted to look at that, and have it in mind. I would just like to see on one page a picture of what we are talking about.

Mr. Owen: We will do that.

Mr. Owen: Do you wish to make a correction as to the date when you performed those experiments that you were just testifying about? A. Yes, I would like to. The question was asked as to the date that these experiments were performed, and in checking carefully I find that they were all performed the latter part of June or the first of July, 1941.

The Court: That includes the one originally shown in typewriting on this sheet PX-171? A. It does, Your Honor.

The Court: And these with the increased percentages? A. That is right. They were all performed within a period of some two weeks or so, the higher concentration ones. They probably started in the latter part of June, perhaps the last week in June, something like that. I haven't the exact date that they were started, but it was during the present summer.

By Mr. Lyon:

Q. Doctor, now have you run any other tests? Are you sure you haven't run any other tests on the subject of

this inhibitor patent in addition to those you have brought into this case? A. In addition to the data that was presented this morning, is that your question?

Q. Including that. Including all the data that you have brought in either this morning or any other morning, are you sure there are no other tests you have made on the subject? A. We probably have made other tests.

Q. Well, where is the data on them? A. They are not included here because the work on that in my opinion was not complete.

Q. Well, have you ever tested any samples delivered to you by any representative of the plaintiff and said to be samples from the defendant's operations, other than the samples from the particular wells that are mentioned in the reports that you have already presented? A. Yes, I do recall one other sample.

Q. I believe you did mention a well that you tested? A. I mentioned a well and at least two or more samples from that well.

Q. Those are all the samples you ever had submitted to you to test say for inhibitors? A. So far as I recall no samples have been submitted to us other than from the wells already mentioned, including at least another well.

Q. Were any samples ever delivered to you by the defendants purporting to be samples from the defendant's operation taken in Kansas? A. I believe not.

Mr. Lyon: It is not clear on the record, Your Honor. Perhaps we can clear this up. Plaintiff, I believe, has made some statements as to whether or not they procured other samples from the defendant's operations around the country, or delivered other samples, and I am informed that many samples have been furnished to plaintiff, and I may be wrong about it. I don't know it of my own knowledge. I only know what is told me, and I would like to know that. I would like to know if they had it tested by this witness, because there is some issue here or may be some issue as to how far the court would treat particular individual instances as representative, and Your Honor has already seen

there is considerable variation, even in the materials presented to you now.

Mr. Conner: This suit was filed on June 15, 1939. Before we filed the suit we had procured all the samples that we are now relying on, except such samples as defendant gave us during the taking of depositions. Now, the intimation made by Mr. Lyon, the record is clear. We have obtained samples of a few in Kansas, and a few in Texas, but those samples were all obtained after this suit was filed, merely for our own benefit to substantiate that what they were doing in Michigan was also taking place elsewhere.

Mr. Lyon: Let's have no mistake on it. Because we will call a witness on this.

Mr. Conner: And the later samples were never submitted to Dr. Bartell at all. The only samples he obtained were samples taken in this state in the months of August and September of 1938, and one sample taken in April of 1939, all prior to filing this suit June 15th. Defendant's intimation here is we have taken samples all over the country and picked Michigan where the infringement is. That is not true, Your Honor. The only samples we obtained after the suit was filed were obtained in Texas and Kansas.

Mr. Lyon: Mr. Conner, just so there will be no question of inadvertence in your statement, I want to have it definitely understood, because I plan to call a witness on the subject. Are you stating that numerous samples from the defendant's operations taken in Oklahoma and Kansas in the years 1936 and 1937 were not delivered to and received by the plaintiff?

Mr. Conner: No, I am speaking only of what I know. I wasn't with the plaintiff company until the first day of 1938. What transpired before then, I wasn't responsible for and do not have. I am speaking and saying it was my duty and job to obtain the samples for this lawsuit. I personally did not take them; the boys brought them in to me. Samples may have been obtained prior to 1938. I don't know.

Mr. Lyon: That is what I am bringing out. Counsel says there were no samples; now he says he doesn't know.

Mr. Owen: There is one other, the Knight well, that I spoke of the other day.

Mr. Conner: I mentioned it.

Mr. Owen: That is going to be referred to in connection with the other patent.

The Court: Well, with that—it is my understanding that all the samples which you ever gave to the doctor, the samples taken prior to the starting of this lawsuit, are then accounted for,—

Mr. Owen: That is all that I know anything about, Your Honor.

The Court: I am satisfied that that is so.

Mr. Owen: No, I will have to apologize to you on that. There was another sample taken—another storage sample—taken when, Mr. Conner?

Mr. Conner: Some time in April, as I recall, of 1939, prior to the filing of the suit.

Mr. Owen: I think that storage sample was delivered to Dr. Bartell, and I think he analyzed it.

Mr. Lyon: Did he make any tests on it?

Mr. Owen: No different from the others.

Mr. Lyon: Did he make any tests on it?

Mr. Owen: You will have to ask him about that.

Mr. Lyon: What I am trying to do is to get all of this work in here, on Your Honor's theory that all of it should be in here.

The Court: I knew that you would, and I was trying to—I know these things are confusing to me, and I think possibly they might be to Dr. Bartell and everybody else, so I was letting counsel try to refresh the doctor's memory about it so that we could get the facts out.

Mr. Owen: My recollection is now as to the reason we did not include those—that later storage sample, was because it was taken just about the time the Knight well was treated, and I think it will be referred to in connection with the Knight well; but if counsel wants to get the information out now, I have no objection to it.

Mr. Conner: The Knight well was treated April 24, and the storage sample was taken April 26, and we were not relying on the Knight well, so we didn't include the storage sample.

Q. Well, did the plaintiff ever furnish you or did you ever obtain in any way any sample of any of the inhibitors that may be used by the plaintiff? A. I don't recall whether plaintiff has furnished us with any of their inhibitor.

Q. Well, did you obtain it in any other way? A. Oh, yes. We obtained them in other ways. Naturally we would have some of them in stock in our own laboratory, and some I obtained from supply houses, such as Eastman.

Q. Now, you brought in a—just strike that out. You don't have any means of knowing what inhibitors plaintiff has used or is using in its acid? A. I don't believe I have any direct information covering that point.

Q. What do you mean by direct information? Do you have any indirect? A. Not other than hearsay. I may have heard it suggested plaintiff is using arsenic or something of that sort, but specifically, no, I have no specific information.

Q. Do you find anywhere in the Grebe-Sanford patent in suit, No. 1,877,504, any direction or statement as to what amount of the specific inhibitor mentioned in that patent shall be used, other than the amount of arsenic compound? A. I don't remember any such directions, no, other than for the specific example of arsenic.

Q. There is no teaching in the patent or no specification or quantitative figure given as to how much of the other inhibitors mentioned therein may or should be used, isn't that correct? A. I don't believe any mention is made of the amounts of other inhibitors which may be used.

Q. Is there any mention in the patent as to— A. (Interposing) Other than—I will qualify that—in Claim 1 the statement is made that an aqueous hydrochloric acid solution may be used to which has been added "a relatively small amount of an agent capable of inhibiting action of the acid upon metals."

Q. Now, what is your understanding of what "relatively" refers to. It says "relatively small." It is small relative to what? A. It might mean anything, depending upon the system one was working with. Working with the substances such as we normally work with in surface chemistry a relatively small amount might mean as small as one part per million.

Q. I am not asking you what it might mean. I am asking you what it does mean? A. That is what it does mean to me.

Q. It means how many parts in a million? A. Oh, it might be one or a fractional part.

Q. I am not asking you what it might mean. I am asking you is there any definite meaning to this phrase that you called attention to. If so, give it to us. A. Well, relatively small amounts certainly would hardly be taken to indicate more than ten per cent.

Q. What makes you think so? A. Well, simply my judgment would indicate that relatively small means exactly what it says, relatively small.

Q. Does it include up to ten per cent? A. I wouldn't expect it to, as I mentioned, anything like that, or five per cent.

Q. What is the basic figure to which this word relatively refers? What is the practice which it is distinguishing from, do you know? Is it identified in the patent? A. The patent refers specifically to inhibition and the main designation is that a relatively small amount of material may be added to produce inhibition and the inhibition effects would tend to be the measure of the thing that one is after.

Q. Is that the best answer that you can make to my question? A. Well, the answer to the question is that to me the term "relative" would represent a comparatively great leeway in the selection of compounds and naturally compounds with different properties might require quite different amounts to bring about a given effect.

Q. I am asking you to what should this word "rela-

tively small amount," or these words "relatively small amount" be distinguished. What is the practice which these words are used to distinguish from? A. Well, the word "relative" as used in this particular patent is written for one reasonably skilled in the art to interpret.

Q. You have to know the prior art in order to be able to interpret it, is that your answer? A. No, not necessarily. I refer to the art of chemistry, surface chemistry.

Q. Now, does commercial hydrochloric acid as determined by your test contain relatively small amounts of copper and lead? A. It contains small amounts of copper and lead.

Q. Relatively small amounts? A. Yes, they are relatively small amounts.

Q. Now, Doctor, let us take mercaptans. They are mentioned as inhibitors in line 3, page 2 of this patent. A. Yes.

Q. Does this patent tell you how much mercaptans to employ in order to constitute adding a relatively small amount of an agent capable of inhibiting, and so forth? A. The patent does not tell what amounts to use.

Q. What? A. The patent does not state specifically the amounts to use, other than a relatively small amount.

Q. Is that the extent of the definiteness of the patent, as to how much of these inhibitors to use, other than the specific formula given in connection with the arsenic compounds, and the 1 to 5 per cent statement at line 86 on page 1? A. The statement is made that other inhibitors may be used, and it specifies the reference to the organic sulphur compounds, such as mercaptans. It does not refer to the definite amount which should be used.

Q. Well, does it tell you how much you are to inhibit the acid, distinguishing now from the quantity of inhibitor to be added, we are now referring to the effect of the inhibitor, and, does it tell you what the magnitude of the effect is to be? A. It refers to an inhibitor which will decrease the danger of damaging the metal portions of the well.

Q. Does it say how much? A. It does not say how much.

Q. Doesn't it tell you the amount of the inhibitor, how much to inhibit this acid, and doesn't it tell you by the effect wanted as to how much you should inhibit the acid—is that your testimony? A. The last part of that question, yes, it does refer to the effect desired.

Q. Well, does it give you a definite measure of the effect that is to be accomplished? A. Enough so that there will not be damage to the casing, for example; and beyond that, there are no specific directions or specifications that I can recall.

Q. Does it say preclude any damage to the casing, enough to preclude any damage to the casing or pipe? A. Well, in my opinion it refers to making use of the acid practically so that the—well, it is my understanding, and as repeatedly has been indicated, that the non-inhibited acid will have a much greater action on the metal parts of the well equipment; while the use of inhibitors, such as these mentioned, prevents damaging of the casing to the extent certainly of making the operation practical.

Q. Well, what I am getting at, does the patent contain any criterion as to how much the acid shall be inhibited? If so, what is the criterion given in the patent? A. It gives one example of the use of the arsenic compounds and states the amounts of the arsenic compound that can be used.

Q. And in your test with 50 c.c. of acid on the specimen of strap iron without agitation that was 97%? A. That is right. That is per cent inhibition.

Q. Does it give any other criteria or any other measure except that? A. Well, the one to which I have previously referred. An effect which will prevent the danger of damaging the casing.

Q. Doesn't it say how much it protects the casing or pipe in that? Does the patent say? A. Well, there is this statement—"In actual practice this method has never been generally adopted due to the fact that the acid"—and that

refers to uninhibited acid—"attacks metallic casing, pump and so forth, about as actively as the rock." And so the implication would be, certainly, that these inhibitors will so inhibit that the action on the casing certainly will be far less than that indicated by the statement I have just read.

Q. Have you made any test to determine whether or not uninhibited raw commercial hydrochloric acid will attack well pipe about as fast as it will attack lime formation? You know that isn't true, don't you? A. I have made no test to get a comparison.

Q. You know it isn't so, don't you, as a chemist? A. I wouldn't go that far to make that statement.

Q. You wouldn't? You made ordinary tests of pouring hydrochloric acid on calcium carbonate or lime. Every chemist does that in high school chemistry. A. But more may be implied in this case. The limestone referred to perhaps is the rock material within the earth formation and it may be that the acid cannot readily get at that material so as to react as rapidly as it would if the material were in a beaker right in contact with the acid. But the acid must get to the limestone before it will react.

Q. Have you computed in thousandths of an inch how deep the corrosion of acid took place in the experiments that you have made? So you can just give us an idea of what it is. A. I haven't made such computations.

Q. Those pieces you used were how thick? A. About an eighth of an inch.

Q. And it is true, is it not, that the greatest corrosion in any of your experiments that you got was less than a thousandth of an inch in 16 hours? A. Well, I couldn't give you exact value but it was nothing approaching the eighth inch depth.

Q. Why can't you give me the exact figures? You can compute it right off your papers, can't you? A. Assuming the value were around 4% loss in weight would indicate—

Q. (Interposing) On all sides. A. (Continuing) —would indicate that there had not been in those tests a

great depth of penetration, unless by chance the penetration should have been in spots or something of that sort.

Q. Well, I am assuming you get an average penetration. You can see offhand it is of the order of less than a thousandth of an inch, isn't it, from the figures you have just referred to. A. Well, I wouldn't say a thousandth of an inch.

Q. Well, you better calculate it then. It won't take you but just a second. You know the size of the test piece and you can assume the maximum four per cent loss, and figure the area of the sample and tell me what the depth of corrosion would be. I can add one thing to help the doctor, remembering that the penetration is from both sides, I think you will find it is two per cent of one-eighth. A. No, it is not as simple as that.

Q. Did you make the calculation, doctor? A. Yes, I did. Using certain assumptions that may or may not—well, that would not be strictly correct, of course, making the assumption that all the loss comes from the side of the plate, which, of course, isn't quite true, but assuming that it did, and assume that the change in thickness was uniform of the plate, the total loss of iron would be expressed in something like five thousandths of an inch.

Q. Now, then, that means on the same assumption two and one-half thousandths on each side, does it not? A. Yes, calculated on that assumption the loss from each side would be in the neighborhood of as you say two and one-half thousandths.

The Court: And inasmuch as there would also be a layer around the edges it would really be a little less than the figures you have given? A. Slightly less, provided the action were uniform throughout, all over the surface.

The Court: And if you applied the loss it would come at the ends and side of the narrow strip running around it, to the two wide sides, as I understand it? A. Yes.

Mr. Lyon: Well, now, you do not find in this Grebe and Sanford patent in suit any definition of the extent to which the acid is to be inhibited, either measured in the

amount of inhibitor used or measured in effect to be accomplished, other than what you have already stated? A. I believe that is right.

Q. Why haven't you mentioned the phrases used in line 15, page 2, where it says, "And such strength of acid, the corrosive action thereof upon metals, particularly iron or steel, can be largely or substantially inhibited"? A. Well, that is a further indication of the results.

Q. Is that a definite indication? A. Which would be expected.

Q. Is that a definite indication, anything definite about it? A. The word "can" appears, "with such strength of acid, the corrosive action there upon metals, particularly iron or steel, can be largely or substantially inhibited by adding thereto a relatively small amount of an arsenic compound or other inhibiting agent."

Q. Well, now, what does "largely" or "substantially" accomplish here? Does it give us any definite quantitative measure or effect that is to be accomplished? A. Well, I would feel that the implication is to the fact—is to the statement that I made in my earlier answers, that corrosive action can be largely or substantially inhibited, to the extent that the process is made practical the casing is protected.

Q. I want to add to that the sentence commencing at line 25 on page 2, which reads,

(Reading): "Due to the presence of the inhibitor there will be no substantial attack upon the pump tube, or upon the well casing."

Isn't it true that there is no quantitative indication or extent of the inhibition called for by this patent except that it shall be such that there will be no substantial attack, or, to put it the other way, that the acid is largely or substantially inhibited? A. Yes, to a degree, but it is assumed that the uninhibited acid will give what would be referred to as a substantial attack, so the implication is that one must compare the attack with the non-inhibited acid with that of the inhibited acid.

Q. Now, let us assume that we have chemically pure acid, which has the maximum amount of corrosive effect; and, let us assume that we have a completely inhibited acid, now, does this patent tell you at what point intermediate to those two you will be—on one side—accomplishing what is called for by that patent, and on the other side not reaching that accomplishment? A. Not in terms of quantitative figures.

Q. Well, the only terms that exist for consideration are these terms "largely and substantially inhibited," and the term "no substantial attack," so far as the effect of any measurement in this patent is concerned, isn't that true? A. Yes. That is essentially true.

Q. I think I will add to that, to make it complete, the phrase appearing at line 96 on page 2, "without appreciable damage." A. Yes. That term also appears.

Q. Well, now, taking all together these terms, which I understand are, first, the phrase at line 15 on page 2 reading "can be largely or substantially inhibited," and next the phrase at line 26 on page 2 reading "no substantial attack," and the next and finally the phrase at line 96 on page 2 reading "without appreciable damage," will you tell me at what per cent of corrosion or inhibition, either one, lying between chemically pure acid and one hundred per cent inhibited acid marks the distinction between practicing this patent and not practicing the patent? A. I can't tell you that.

Q. Why not? A. I do not know.

Q. Can't you tell from the patent? A. But I have been asked for a specific value and my experience is not such that I could give you a specific value.

Q. You cannot find that value in this patent; is that correct? A. No, the value is not given in the patent.

Q. You are not willing to subscribe to the proposition that the phrases "largely or substantially inhibited" and the other phrases connote an acid which has been inhibited to the extent advertised by the plaintiff, to-wit, 99 per cent, or the extent you found with the arsenic formula, to-wit, 97

per cent or thereabouts? A. The question is put in the negative there somehow. I would like to answer it by stating that I am willing to subscribe—if you will read the question once more, I will try and answer it.

(The question was repeated by the reporter and the question in writing was handed to the witness.)

A. (After examining the question): I would be willing to subscribe to the phrase "largely or substantially inhibited," when used to refer to the plaintiff's acid which has been inhibited to the extent of 97 or 99 per cent.

Q. Would you be willing to do so as applied to the Detroit Chemical Works acid which when tested with the Atha Supply Company metal gave a per cent of reduction in corrosion of 18.4 per cent? A. I would be willing to state that that acid has been inhibited.

Q. Would you be willing to say it was largely or substantially inhibited? A. It would depend upon whether—I would feel that it would depend somewhat on the purposes to which the acid was to be put.

Q. Well, assume that we are going to use it for acidizing a well in a limestone formation? A. I would say the acid is inhibited, and I would feel that the tests, such as I have described, showing inhibition, might not serve as a sufficient criterion to indicate the extent to which the inhibition would exist in the well.

Q. Now, in order to obtain any meaning for the word "substantial," or "largely," or "appreciably," which are comparative words, as I understand it, it is necessary to know the starting point with which to compare them. Do you agree to that, doctor? A. In general, yes.

Q. Now, what do you understand to be the starting point in the case of the words that we are inquiring about, chemically pure acid or commercial raw acid? A. Well, the only definite yardstick, of course, would be the chemically pure acid.

Q. You do not believe that this patent, in discussing inhibited acid, is intending to go back and use chemically pure acid as a starting point, to the exclusion of commercial

raw acid, do you? A. That would not be my opinion, no.

Q. If we are going to use chemically raw acid as the starting point for this comparison, can you place any limit on the percentage of reduction in corrosion that you would tolerate in such a commercial raw acid? A. I feel that it would be necessary to place some restriction on that, yes.

Q. Does the patent give you any guiding restriction, the patent in suit, the Grebe-Sanford patent? A. Not in terms of quantitative values, no.

Q. How are you going to tell from this patent, if you can tell, what the starting point is that you are to employ for the purposes of comparison in interpreting these terms "largely," "substantially" and "appreciably"? A. I have nothing to add to the statements that I have previously made on the same question.

Q. Well, you mean to say, then, that there is no criterion to that starting point in the patent? A. There is no quantitative scale set up, no.

Q. Now, what we are interested in in the— A. (Interposing) In terms of figures.

Q. What we are interested in when we talk about substantial attack on the pipe or the words "largely" or "substantially" inhibited, is the corrosive effect of the acid in question, are we not? The rate at which it would corrode pipe or steel? A. That is involved. That is involved; yes.

Q. Now, would you say that this patent contained any criterion by which you could state, with respect to the corrosion rate, what was embraced within the terms "largely" or "substantially" or "appreciably" as distinguished from what was excluded by those terms? A. There are many types of experiments or processes in which it would not be possible to set up, perhaps, a simple set of criteria to cover all cases. I have already called attention to the fact that when the system is allowed to remain unagitated one gets a certain type of—certain rate of corrosion, while if the system is agitated somewhat one obtains a different rate of corrosion. If one has a certain ratio of metal to acid one gets a certain rate of corrosion; if the ratio is somewhat

different one obtains a different rate of corrosion. So it is perfectly evident from that statement alone that it would be a little bit difficult to set up a quantitative measure covering this word "substantial inhibition," for these different inhibitors.

Q. Well, now let's compare again the matter that I brought up here the other day. On the basis that the defendant's sample which you tested in a particular manner showed 47 per cent reduction in corrosiveness and the plaintiff's formula of this patent showed 97 per cent under similar conditions, I believe you testified that the defendant's acid was seventeen times as corrosive as the plaintiff's formula. I use the word "plaintiff's formula" to refer to this specific formula in the patent. Now, is there anything in the patent in suit to indicate whether or not one acid is largely or substantially inhibited with respect to the other when that acid is 17 times as corrosive as the other? A. No, there is nothing in the patent referring to that. Neither is there anything in the patent demanding that certain volume relations be observed.

Q. Now, if the plaintiff's—I mean if the specimen of the defendant's acid is 47 per cent reduced in corrosiveness, and you compare it with this Detroit raw commercial acid which is 18 per cent, how many times more corrosive is the Detroit raw commercial acid than the defendant's acid? A. Well, if the reduction in corrosiveness of the one is 47 per cent it means its corrosive effect still is 53 per cent. And if the reduction in corrosiveness of the other is 18 per cent it means that the corrosiveness of it is 82 per cent, so the ratio is 53 to 82.

Q. Which means that the raw commercial acid in question would be one and one-half times as corrosive as the defendant's acid, does it not? A. Approximately that. Not quite.

Q. Well, now, let's apply that to these terms "largely" "substantially" and "appreciably" in this patent. Would you say that the defendant's acid in that case was substantially as corrosive as the raw commercial

acid that I have referred to since it is only one one-half times as corrosive, or would you say it was substantially as corrosive as the formula of this patent in suit since it was 17 times as corrosive? A. To give a complete answer to the question I would want to test the corrosiveness under various conditions.

Q. I am just taking—accepting for the moment that you are going to answer based on these comparative tests—that you testified to, to-wit: That the Detroit raw commercial acid had an 18% reduction in corrosion whereas the defendant's sample had a 47% reduction in corrosion under the same conditions. A. I would say it was substantially more inhibited, yes.

Q. Well, is it substantially like the raw commercial acid with respect to its rate of corrosion or is it substantially like the formula of this patent in suit with reference to its rate of corrosion? A. It might apply to both. The term "substantially" might apply to both.

Q. Might apply to both? Will you please explain what you mean by that? A. May I have the original question read, please?

(Whereupon the question was read by the reporter.)

A. It is rather a difficult sentence to analyze. May I have it once more, please?

(Whereupon the question was again read by the reporter.)

A. I have answered, I believe, that I feel "substantially" would apply in both cases. Can the question be made more specific if that answer is not satisfactory?

Q. Is that the best answer you can give to the question? A. I feel it is a suitable answer.

Q. Well, let's put it this way: Compare it to the raw commercial acid on the one hand and the 97% inhibited acid of the patent in suit on the other hand. As to which is the rate of corrosion of the defendant's sample most comparable? Which is it most substantially like? Is it substantially more like the raw commercial acid or substantially more like the formula of the patent in its corrosion rate?

A. If I understand the question correctly, the truck tank sample with its reduction in corrosiveness of 47%—

Q. (Mr. Lyon interposing): Remember it is only one one-half times as corrosive as the raw commercial acid. Now, isn't it more like that in its corrosion rather than it is like the corrosion rate of something that it is 17 times as corrosive as? A. As to the amount of corrosion which would be caused by these two acids under consideration under which the experiments we are referring to were run, it is true that for a given experiment the truck tank sample would reduce a loss in weight of iron more nearly in amount like the raw commercial acid than of the sample of the defendant's inhibited acid.

Q. Now, as you understand the wording of this patent as a man skilled in the art, would you say the patent includes and covers the use of that 18 per cent Detroit raw commercial acid? A. I would feel it might if it were found that under conditions of operation that Detroit commercial acid produced an effect which made it possible to use it to advantage. May I have the question before I put the period there, if you please, to be sure that I have understood the question?

(Question read.)

Q. I mean by 18 per cent the raw acid has an 18 per cent reduction in corrosiveness as compared with chemically pure acid? A. And my answer is it might.

Q. That it might? A. It might, yes.

Q. I can't get very far with the word "might." A. No.

Q. In your opinion does it or does it not? A. I have just previously stated that under the condition of my experiments it was shown that the acid is inhibited. Now, whether or not that inhibition might be sufficient in practice to make that acid outstandingly better—

Q. What is that term you used? A. Outstanding or substantially or very materially better. As to whether it would be materially better under other sets of conditions would have to be determined by running experiments under

other conditions. My experiments went this far, they showed that acid was inhibited, contained something that served as an inhibitor, and that is as far as that particular set of tests of mine that I described were supposed to go.

Q. Well, now, you have referred to the fact that you would have to determine whether or not that amount of inhibition had a quantitative effect, that is right, isn't it? A. Right.

Q. Now, does this patent tell what this quantitative effect is? A. It doesn't mention it in terms of figures, no.

Q. Does it mention it in any definite terms? A. It implies that the effect must be such as to make the improvement of value.

Q. Of value. Is that all that it claims now; is that all the quantitative indications of this patent on that point signify to you? A. To me the patent signifies exactly what it says in claim 1. "In a method of increasing the output of a well for producing a fluid mineral product such as oil, gas, water or brine, the step which consists in introducing into the well an aqueous hydrochloric acid solution to which has been added a relatively small amount of an agent capable of inhibiting action of the acid upon metals."

Q. Now, why wouldn't that fit any commercial hydrochloric acid which was put down a well for the purpose stated for that commercial hydrochloric acid containing amounts of copper and lead? A. Apparently the patent refers to the use of commercial acid; and apparently the patent refers to the addition to such commercial acid of agents which will produce an inhibiting action.

Q. Do you find that definitely stated in the patent? Do you find that this addition is to be to commercial acid, as distinguished from chemically pure acid? If so, will you please point that distinction out in the patent, or, that statement? A. I do not recall that the word "commercial" is used in respect to use in the patent.

Q. Do you understand from reading this patent that when they speak of an addition of a small amount of an agent capable of inhibiting the acid, that they are speaking

of an addition to commercial acid, or are speaking of any addition to chemically pure acid? A. Well, it would be my interpretation that the patent refers to the addition of such agents to commercial acid.

Q. And, therefore, any inhibiting agents that were present in commercial acid and raw acid as a result of its manufacture would lie outside of the added agents to which the patent refers? A. I would think so, if the manufacture is by a normal process of manufacture.

Q. It is true, is it not, that all raw commercial hydrochloric acid contains some amounts of lead and some amounts of copper? A. I could not say how much.

Q. Don't you believe that to be true? A. Well, all I have examined here have contained some, yes, sir.

Q. Now, then, I want to find out if I can if this patent gives us a starting point with which to compare either the amount of agents that are to be added, by weight, or by effect, and I think you have stated now the first premise in establishing that starting point is that we are to start with raw commercial acid though we are not restricted, or not set back to chemically pure acid. Do you agree on that? A. I would be inclined to, with the proviso that I made in my last answer.

Q. Now, then, how much lead or copper would you allow to exist within that raw commercial acid, and still be within the starting point to which we are referring? A. (after examining a book): To answer that question correctly, I would want to—if a definite criteria is to be set up to cover all time, I would want to know the average composition of practically all commercial acids. The evidence is that the available commercial acids contain a copper content somewhere in the neighborhood of three-tenths of a part per million, when those acids are diluted down to approximately 15 per cent acid.

Q. Now, you say in the "neighborhood." I suppose that is the average figure you have given? A. It would be close to the average, the values I have.

Q. What are the extremes? A. The extremes are as

follows: From .24 up to .37 of copper, parts per million.

Q. Now, do you know whether or not that represents the extremes that would be found in actual commercial acids? A. They happen to be the values in all that I have happened to analyze this way.

Q. You haven't made any study further than that? A. I have not made a study further than that.

Q. Do the handbooks, if you know, contain any data on the percentage of copper and lead which may be expected in commercial hydrochloric acid? A. I don't know of such data.

Q. Have you ever examined them to see? A. No, I haven't. I don't believe you would find it. I don't believe you would find it.

Q. Does the patent in suit give any quantitative figure or quantitative value for the amount of inhibitor or copper or lead that may be allowed within the commercial hydrochloric acid which you say is to represent the starting point for the purpose of comparison in this patent? A. No, it does not.

Q. Then if you were the operator of a well, and you employed a service company to come out and acidize your well. They came out and brought a tankful of acid, and before that acid went down the well you tested the acid to see whether or not it was inhibited in the sense of this patent. What would guide you at that point in saying, "I can use this acid without violating the patent," or, "I must tell this operator he cannot be permitted to put that acid down my well because it will infringe the patent"? What would you have to know and how would you determine it, assuming you had the patent before you and were thoroughly familiar with the wording of the patent? A. May I have that question, please?

(Question read by the reporter.)

A. May I ask a question about the question?

Q. Oh, yes. A. The question was if I were the operator?

Q. Yes? A. Then naturally, if I were the operator, I

would know what I now know, and if I were to examine that acid and found that acid to contain copper, for example, in amounts somewhat greater than the values I have stated, I would have my suspicion that copper had in some way gotten into that acid after having left the manufacturer. Hence, I would be suspicious that that acid might be inhibited.

Q. Well, let's suppose you are just the ordinary oil well operator to whom this patent is directed, and you haven't made the tests that you have? How could you tell then? A. Probably if I were an oil well operator I would take the commercial acid delivered to me.

Q. Well— A. If I were the operator.

Q. I am saying that you have heard that the Dow Company is asserting this patent, and you are liable to be sued if you put any acid down the well that is covered by this patent, and this company that you have employed brings out some acid, and you say, "Wait a minute. I have got this patent here and I have read it. I want to test that acid and see whether it is an infringement of this patent or not." How could you tell? A. I would say you better take that acid to the laboratory and have the chemist investigate that acid and determine whether or not that is inhibited. That would seem the logical thing to do.

Q. Now, you have done that. Would you say that the acid—if you, we will say, found the acid had an 18 per cent reduction in corrosive effect, that that established that the acid was covered by the patent? A. I would be rather suspicious of the acid.

Q. I am not asking about being suspicious. I am asking you would you be able—would that establish, as you read this patent, one skilled in the art, is an infringement of this patent? A. I would feel that it might be.

Q. I am asking just a plain, simple question, and not whether it might be. But as you read the patent, does it or does it not? A. If it would be discovered that an inhibiting agent was deliberately placed in that acid, as it may be, why then I would feel I was infringing.

Q. If it hadn't been deliberately put in there but had just arrived there in the normal manufacture of the acid, would your answer be the opposite? A. I have indicated that by a previous answer. Yes, in normal methods of manufacture without the addition of anything.

Q. How much of the inhibiting agents arriving in the acid only due to its normal method and process of manufacture would you tolerate? Or, if you want to express it in per cents of reduction in corrosion in a raw acid, without saying that it violated this patent, assuming that there was no addition subsequent to the normal manufacture of the acid? A. Well, I would feel that an amount such as was represented by the storage tank acids of the defendants would quite likely indicate a suitable value.

Q. That isn't my question. I am asking you how much greater than that could it be and still be permissible? A. Well, anything greater than that might indicate the presence of an added inhibitor.

Q. I am not asking you what it might indicate. I am asking you, assume that it isn't added in the sense that you are referring to, would you allow any amount of inhibitor in there that was caused by the normal method of manufacture of the acid? A. If it isn't added, it can't get there. My answer would be inclined to be I see no reason why it should.

Q. What do you mean "if it isn't added it can't get there"? A. If more of these metals are present in the truck samples than in the storage tank samples, the metals must have gotten there in some way.

Q. Well, would you allow the use of a raw commercial hydrochloric acid for the purpose of the starting point, which we are interested in, if that acid contained no added inhibiting agent in the sense that you referred to but contained amounts of copper and lead sufficient to reduce the corrosive effect of the acid by 18%? A. I would be very suspicious of an acid that would reduce the corrosiveness to 18%.

Q. I am not asking you would you be suspicious of it,

I am asking you if you would allow it. A. If I were in the position that you have suggested I consider myself and had the responsibility attendant to that position, I would want to check up on it immediately. So in that respect I would not allow it.

Q. Then, as a matter of fact, in order to establish a starting point which is necessary for interpreting this patent here in suit, you cannot do it from the patent itself. You have to go and find the acid and examine its method of manufacture, make tests on it to determine the amounts of copper and iron it contains, and find out its per cents of reduction in corrosiveness rather than reading that and relying on the data that is in the patent in suit, is that correct? A. The patent does not discuss the normal impurities.

Q. Then, as a matter of fact, you couldn't establish the starting point from this patent from the wording of the patent itself? You have to go outside of the wording of this patent and make some other kind of determinations? A. I wouldn't say that because I have indicated that I would feel that it would be perfectly permissible to use commercial acid, assuming no inhibition, but if I found the acid did contain inhibitor, then I would feel that it was time to investigate.

Q. Well, all right. Now, can you get the answer as to those acids from this patent? A. No.

Q. Or have you got to go out and look at something else? A. No, you can't get the answers from that patent. It doesn't tell about the manufacture of hydrochloric acid.

Q. And the point that you have got to ascertain then is whether or not the manufacturer deliberately added an agent that wouldn't get into his acid by its normal method of manufacture, is that the point? A. I think that is the thing one should know, yes.

Q. Now, how are you going to tell whether this copper and lead got into the acid in the normal method of manufacture, or got in there by intention? Do you know enough about the manufacture of commercial hydrochloric acid so

you could go in a plant and tell whether they were deliberately adding copper and lead, or whether the presence of copper and lead was due to the normal operation of the manufacture of the acid? A. I could tell this; I could tell whether or not the copper and lead content was above that of the acid when manufactured, and to answer—

Q. (interposing): We are not talking about that. We are talking about this examination to see whether it has been added or not. What do you mean by added, something that you strictly—the term "added" is something after the acid is finished, or something that was done in the manufacture of the acid? A. I refer to after the acid is finished. Perhaps I didn't answer completely your first question there.

Q. Then you think that the real criterion for this patent and the starting point, so-called, is that this patent covers the deliberate addition of an inhibiting agent to a commercial raw hydrochloric acid where that acid is to be put down an oil well to treat a lime formation, you think that is what the patent covers, irrespective of the amount of acid. I mean irrespective of the amount of inhibitor added, and irrespective of the effect as to the percentage of reduction in corrosion? A. I feel that the patent does call for the addition of material to normally made hydrochloric acid which will lower—which will give an inhibiting effect.

Q. Irrespective of the amount of the added agent, or irrespective to the extent of the lowering of the corrosiveness? A. That is my opinion.

Q. That is your opinion? A. Yes.

Q. Do you find that stated in this patent? A. As to the amounts of material?

Q. Yes. A. Yes, it is.

Q. Isn't the information— A. (Interrupting): It is stated in these words: "The hydrochloric acid solution to which has been added a relatively small amount of an agent capable of inhibiting action of the acid upon metals." That is the statement.

Q. That is to be read, is it not, in the light of the speci-

fication, which refers to largely or substantially inhibited, at line 15, so that there will be no substantial attack, as stated at line 25? A. The claim 1 contains no such word as "substantial." The claim 1 states as I have just indicated, reading the entire claim again, if I may, to have that clear:

"In a method of increasing the output of a well for producing a mineral product such as oil, gas, water or brine, the step which consists in introducing into the well an aqueous hydrochloric acid solution to which has been added a relatively small amount of an agent capable of inhibiting action of the acid upon metals."

Q. All right. Now, how does that claim differ from a raw commercial acid containing small amounts of copper and lead? A. In this way: It says an acid solution, an aqueous hydrochloric acid solution to which has been added a relatively small amount of an agent capable of inhibiting the action.

Q. Well, then, for the difference you depend upon the word "added"? A. Added after manufacture, yes.

Q. Added after manufacture? A. After the normal process of manufacture, that is my understanding of that patent and claim.

Q. And any addition of that kind, no matter how small it is, you think is included and covered by this patent? A. It is covered by claim 1, in my opinion.

Q. But you think the addition must be intentional? A. Well, I would feel that is a matter of law.

Q. I am just asking you to read this patent now. As I understand it you are saying that the difference between this claim, and this patent as represented by this claim, and the starting point just outside of the patent resides entirely in the intentional addition of the inhibitor after it is manufactured? A. I do not think that is a fair statement.

Q. Do you know anything about the defendant's method of operation? A. No, nothing, only—

Q. Have you made any tests on it? A. I know only what I have heard about the method. I have never seen the method carried out.

Q. Have you ever made any tests having any bearing on the defendant's method? A. Why, it—

Q. Other than these that you have produced here? A. I think practically none.

Q. Well, any? A. Well, in considering any preliminary experiments, I think—at the moment I think of practically none. What they might be, they would be in the nature of preliminary experiments, or something of that kind, if we made any; but those are essentially all of the experiments that we have made. The information that we have here was essentially the information we set out to get from our experiments, and which we have presented.

Q. Do you know whether or not the purpose of the lead plate bonded into the defendant's tank is to protect its tanks? A. I think I have heard the statement that they were there for that purpose.

Q. Have you any idea how much longer the defendant's tanks last with the lead plate bonded in there than they do without it? A. I have not.

Q. Can you give us an idea, based on your knowledge of the corrosiveness of the raw hydrochloric acid? A. I couldn't give data that would have much bearing on that point, for the simple reason that I am inclined to believe that information one can obtain concerning normal action, as far as metals are concerned in solutions at the source, will be quite different in solutions of 15 per cent acid, and I have not enough information to hazard a guess as to what the reactions would be in the 15 per cent hydrochloric acid.

Q. You are not in position then to compare the causes for the existence of these small amounts of lead and copper in the well, as it arrives at the well, with respect to whether or not that is incident to the protection of the defendant's tanks? A. I have made no study of that.

Q. Further, in connection with this starting point for patent 1,877,504, what is the difference in corrosiveness of the two ordinary raw commercial hydrochloric acids, and one of ten per cent strength, and one of fifteen per cent strength, or twenty per cent strength? A. I have no data to show on that.

Q. Well, this patent in suit specifies, does it not, that a hydrochloric acid may be used of the strength varying from 5 to 20 per cent? A. It does.

Q. Or more. And, as a matter of fact, would the corrosiveness or, the rate of corrosion of those two strengths of acid, 10 and 20 per cent, vary more than the difference in variation between the defendant's well acid samples that you tested and the raw hydrochloric acid in the defendant's storage tanks? A. I couldn't say. They might.

Q. Well, try to figure it out, will you? A. You can't figure it out offhand.

Q. What. A. You can't figure it out offhand.

Q. Don't you know anything about the difference in the corrosion rate of 20 as compared with 5 and 10 per cent hydrochloric acids? A. No, nor anyone else, without having access to data of some sort with such experiments.

Q. Now, have you made any—just strike that for a moment. In the exhibit that you produced this morning, Plaintiff's Exhibit 171, you report certain tests with acridine, aniline, pyrodine and quinoline. You also reported your tests with arsenic. Didn't you make any tests of the other inhibitors referred to in the Grebe and Sanford patent in suit, commencing at line 87 on page 1? A. Not that we have completed.

Q. Not that you have what? A. Completed.

Q. Have you ever tested the cyanides? A. No, we have not.

Q. Have you ever tested the organic nitrogen bases? A. Well, some of these things we have mentioned are organic nitrogen bases.

Q. How about the phenyl-hydrazine? Have you tested that? A. That is the one that we now have under test.

Q. How about mercaptans? Have you tested those? A. We have tested no mercaptans.

Q. Why not? A. We just haven't.

Q. Don't you know, as a matter of fact, or haven't you been told that that is the inhibiting agent that the

plaintiff uses commercially and has used for some years? A. We have not.

Q. You never asked what inhibitor the plaintiff uses? A. I don't believe I ever did.

Q. Nobody told you that that is what the plaintiff used or asked you to test that? A. No.

Q. To make any comparative tests of that? A. No one has.

Q. Well, who have you contacted in this case? Who gave you your instructions on behalf of the Dow Company, of the work you were to do in this case? A. I think the legal counsel here.

Q. Which one? Any particular one of them? Somebody come and arranged with you to do this work and told you what they wanted you to do? A. They did. And I stated in the first of my testimony the other day we were asked to do two things, and as to whom it was, I think perhaps it was Mr. Conner. I wouldn't be positive, but I think it was Mr. Conner.

Q. Were the arrangements made with you? A. Yes, they were made with me. I was simply asked to make the—

Q. He looks more like the man that made the arrangement with you than anybody else around here, doesn't he? A. I beg your pardon?

Q. He looks more like the man that made the arrangement with you than anybody else around here, doesn't he? A. Well, as I recall, Mr. Conner was present the afternoon I was asked to make those measurements. I don't recall who might have been there. I think others were along. Well, I wouldn't be sure. I think possibly Mr. Chamberlain may or may not have been there. I think he was.

Q. I think that is probably safe, he may or he may not. I think that is pretty safe to say that. We are trying to find out what the possibilities were. We are trying to find out what happened. A. What happened, I was asked to make a test of some solutions. I was given those solutions and asked to make the test that I have already mentioned, sample tests.

Q. That is all you were asked to do? A. That is all I was asked to do.

Q. Did they give you a copy of this Grebe and Sanford patent? A. I don't remember that they did at the time. I have since gotten a copy.

Q. How long have you had a copy? A. Oh, over a couple years.

Q. How did you find out that these tests were pertinent to this patent? A. Well, I suppose from the patent.

Q. How did you know that there was such a patent? A. Well, I suppose the patent was given me, certainly.

Q. Do you remember? When you undertake employment in a case like this to do experimental work and are asked to be an expert witness, don't you know who comes to see you and arranges the matter with you; don't you know what instructions are given you, and what material is handed to you? A. I was not asked to be an expert witness when I was first given the solutions and asked to examine them.

Q. When did you find out you were going to be an expert witness in this case? A. I don't remember. Some time after that.

Q. Have you ever been an expert witness in any other case for the Dow Company? A. I think I have in one.

Q. Have you or haven't you? A. I have.

Q. A patent case? A. It was.

Q. Well, that is the only other one? A. I believe that is right.

Q. Then this isn't so common a thing the Dow Company coming and asking you to testify as an expert for them it didn't make some impression on your mind as to what they wanted and what they wanted it for? A. Just to clarify the issue, I may state the company have asked me to examine things in a referee capacity, which had, so far as I know, no bearing, it did not involve me as an expert witness in the case.

Q. Don't you think it would have been rather an intelligent thing to have done in making these comparisons,

in preparing for testifying in this case, to have asked the plaintiff which one of these inhibitors they were using and make a test of that? A. I don't see that that has any bearing on the point. That has nothing to do with the things I testified about.

Q. How about slug acid? Did you make any tests with that? A. What do you mean by "slug acid" please?

Q. From oil refining. A. No, we made no tests with that.

Q. How about residues from acid sulphite paper manufacture? A. We made no tests of that.

Q. How did you come to pick these particular inhibitors that are mentioned on your Exhibit 171 out of this list and test those and not the others? A. Well, we had those available and those were definite.

Q. What do you mean you had them available? A. In our laboratory, in our chemical laboratory.

Q. You didn't have any mercaptans in your laboratory? A. I am not sure whether we did or not, and what's more, the particular mercaptan isn't indicated. It might have been any one of a number of different things.

Q. What difference does that make? Make any tests on that? A. We could have tried them.

Q. What? A. One could try any one of a number.

Q. I mean do you know whether it makes any difference—the difference between one mercaptan and another? A. I expect it would.

Q. Have you tried it? A. I have not.

Q. Well, now, you have sand blasted all these samples— A. (Witness interposing) We did.

Q. In the case of each test that you reported here the metal was sand blasted, is that right? A. Before testing, yes.

Q. Isn't it true that sand blasting a surface like that greatly increases the area of the surface that is exposed to the liquid? A. It probably would increase it somewhat.

Q. Well, you know it would, don't you? A. It depends on the condition of the surface before it is sand blasted.

Q. Did you make any tests so you can tell us how much the area of those surfaces that were exposed to the acid was increased by the sand blasting? A. No, we made no such tests.

Q. Did you try any tests where the samples were oiled before they were put in the acid? A. I don't believe we did. I don't remember such a test. I don't know why I'd do it.

Q. You didn't try? A. So far as I remember, we didn't try.

Q. True, isn't it, in order to corrode a steel surface the acid must wet the surface? A. It must get to the surface.

Q. It must wet it, must it not? A. Depends on what you mean by "wet."

Q. Take your definition of wetting. I am sure it is better than mine would be. A. If you take my definition of wetting, yes.

Q. Maybe you better state to the judge, if he doesn't understand already, what your definition of wetting a surface is. A. Wetting of a surface constitutes a process in which when a liquid comes in contact with a surface there is a change in energy at the interface.

Q. Now, then, if you applied an oil bath or oil film on this metal piece before you dipped it in the acid, do you know whether or not that would have any effect on the wetting of the metal by the acid? A. It's a guess. I would guess it would.

Q. Well, I think it would be a pretty safe assumption, without asking you to give any quantitative values, to assume that the rate of corrosion of a steel pipe by acid flowed down through the pipe would be different in the case of the acid being preceded by a flow of oil than if the inside of the pipe was clean or sand blasted? A. How different I wouldn't know.

Q. But it would be different. A. I would expect it would be some different. How different, I wouldn't know.

Q. And you didn't make any tests along that line?

Mr. Conner didn't suggest you make any tests with these pieces of metal after they had been oiled? A. No such tests were suggested.

Q. Did he tell you that in the defendant's acidizing process that the acid is preceded down the pipe by a column of oil? A. Well, at the time we started our tests, I don't think he did because our instruction was specific and did not include a discussion of the defendant's process.

Q. Has he since mentioned the fact to you and asked you to conduct any experiments on the basis of oil specimens? A. No.

Q. But has he mentioned to you that that is one factor that will influence the rate of corrosion down a well pipe? A. The answer to the question would be no, he has not told me that. On the other hand, I may have been told that the oil is in contact with—has been in contact with the pipe, but no one has told me the thing indicated by the question.

Q. Dr. Bartell, referring to the instructions that you received from the plaintiff's representatives as to the work or tests they wanted you to make for the purposes of this case, did they ask you to analyze these samples for lead, copper and iron, or was that your own idea? A. As I recall, that was our own idea.

Q. They didn't tell you that those were examinations or tests that they wanted made? A. As I recall not.

Q. What led you to analyze the samples only for lead, copper and iron? A. Well, an examination of the samples would readily show the presence of considerable lead, so it is perfectly obvious as to why we would test for lead.

Q. You could tell by just looking at the sample? A. No, but the simplest of qualitative analysis would show upon that.

Q. What about copper? A. Copper is not so readily detected. After going that far and finding that lead was present, and knowing that something else was probably present, because of the inhibition effects that we were getting, we naturally tested for other metals.

Q. As I understand it, this inhibition or reduction in

corrosion that you referred to could not be accomplished by the lead itself, because lead has a very limited action, and the results are due to the presence of copper in conjunction with the lead? A. As I recall, we made a test with lead salts alone to see whether that much lead would cause the inhibition that we obtained, and it did not cause as much as we obtained, so we suspected that something else must be there.

Q. Did you examine the storage samples to see if they contained any other agents or chemicals other than hydrochloric acid, water, and lead, iron and copper? A. We made qualitative tests for other things.

Q. You found some other things, did you not? A. Not in appreciable amounts, no.

Q. Well, didn't you find some arsenic in the storage,—in the raw acid? A. Not with the tests we made, the regular qualitative tests.

Q. You didn't examine sufficiently to determine whether there were any other chemicals in the raw commercial acid which could function as inhibitors? A. We didn't make an exhaustive analysis, no.

Q. I did not ask you about exhaustive. Did you make any analysis? A. I just mentioned that we did make some qualitative analyses.

Q. Have you got a complete analysis of those samples from the defendant's storage tanks, as far as you made a qualitative analysis, have you got a complete report? A. No, I have not, beyond the three metals.

Q. What else did you find in the raw acid qualitatively? A. I don't remember that we found anything.

Q. Would your notes show it? A. Well, after having found lead and copper and after having found the inhibiting effects we did I am not sure we looked beyond that, except we did make some qualitative tests for arsenic.

Q. Was that the only thing you made the test for? A. Just about, I think.

Q. These abouts and maybes are difficult for me to use your testimony on. I asked you, did you make any

qualitative tests for anything else? A. I will have to consult with Mr. Cardwell.

Q. That is perfectly all right. He is in on this at all stages.

The Court: I suggest one of you help the other in any way you want.

A. Mr. Cardwell informs me we did what I thought we did, we took the regular qualitative analyses scheme for detecting the inorganic constituents and did not find appreciable quantities of anything else.

Q. Well, have you got your qualitative report here so that we can see what you did find in the raw acid? A. I am quite certain we haven't. I don't know we even kept a record of it. Perhaps Mr. Cardwell would be willing to answer that question.

Mr. Cardwell: We have a record of it, but it is not here in the courtroom today.

Q. Is it in town, do you know?

Mr. Cardwell: Yes, sir.

Mr. Lyon: I would like to have it sent down to me, if you would.

Q. Did you examine these—well, as I understand it, you did not make any quantitative tests? A. We did not.

Q. About anything, for anything except lead, copper and iron? A. That is right.

Q. And you say you did not find in the raw acid or in the defendant's well acid at the tank, at the well, any other inhibitor except copper, lead and iron? A. We did not find them, no.

Q. Did you analyze the samples for oil, particularly the tank samples at the well, to see if they contained oil? A. Well, if there were oil present on the sample one would expect the oil to be on top of the sample, and no analysis was made of the solutions received for oil content.

Q. I believe you stated that in the case of the Crawford sample the oil was readily observable on top of the sample? A. Yes, there was considerable oil on top of the Crawford sample.

Mr. Owen: I beg pardon. That is the Stella Wilcox. A. That is right.

Q. (By Mr. Lyon) Excuse me. A. I am sorry.

Q. Now, what other samples from the defendant's tanks at the well did you look to see if there was any oil observable on the surface of the sample? A. We observed to note whether there was oil on the sample.

Q. Was there some in each case? A. There may have been traces on some of them.

Q. Did you examine—did you make a qualitative determination to test for the presence of oil in connection with those samples? A. I don't believe we did, with those samples, because, as I recall, they at most would be but traces of oil on the samples.

Q. Did Mr. Conner explain to you that in these operations from which these samples were obtained from the defendant's tanks at the direction of the Dow Company that the oil was circulated in the system so that the acid would be, when circulated, would pass through passages that had had oil in them, and be subject to contamination by oil?

Mr. Conner: If you please, Mr. Lyon, I think that is a misstatement. Such a fact as you are talking about only happened at one well. I suggest you refer to the record of the testimony taken at Midland.

Mr. Lyon: I am cross-examining the witness to see what they told him.

Mr. Conner: Perfectly all right, but the question is incorrect as to the facts you are assuming.

Mr. Lyon: I am asking the witness. A. May I have the question, please?

(The pending question was read by the reporter.)

Mr. Wiles: If that is not the fact it is an entirely improper question. Counsel can't ask a question of that sort unless the facts are truly expressed. He can't use that kind of entrapment.

Mr. Lyon: That is my understanding of the fact. It doesn't make any difference. I don't think counsel has the

right to get up and prompt the witness in answering the question.

Mr. Conner: We weren't prompting the witness here, Your Honor.

The Court: As I understand the question, it might be, and I don't know whether it is,—I wouldn't think he ought to ask a question unless it has already been proven or you have reason to think you will prove it.

Mr. Lyon: That is right.

The Court: You may not be able to. You might find something happens. But if you thought you were going to prove that, or if you claim it has been proven—

Mr. Lyon (Interposing): I understand that they admit it was true in one of these wells, and it was my information it is true in all of them. Maybe to a less degree.

The Court: Well—

Mr. Conner (interposing): Well, now, I would like to get it straight. The testimony is already in as to how these samples were taken. The opposite side was there and cross-examined. I think to Mr. Babcock's satisfaction it was determined when and where and how these samples were taken. They all came out of the manhole of the defendant's oil truck, and it is true in one case, which was the Crawford well, treated September 10, 1938, even though the acid came out of the manhole at the top part of the oil tank, it came out at a time after they had circulated the acid back from the tank through a valve and back into the tank again, which was their normal practice in this instance because they were mixing the acid with a substance called Klersol, which is not here in suit.

The Court: Would you have objection to it—because I am not sure I understand—if it was limited to that one sample?

Mr. Conner: If it is limited to the facts and correctly quotes the facts.

The Court: I mean—

Mr. Conner (interposing): Yes.

The Court: Not the rest.

Mr. Conner: If he limits it to that one case.

The Court: It would seem to me it is all right. All he is asking him to do is to tell him that, and it would not be surprising to me if he didn't. I don't know anything about that.

Mr. Conner: I am probably just an old fuss-budget, but what I hate in this case is a loose use of the record.

The Court: Has that been proven in one case?

Mr. Conner: Yes.

The Court: I don't see it would be anything bad to ask if the witness was told that. I am not saying you can think of everything in the world that was told him; I don't see any objection to finding out whether he was told or not. I will let him answer that. We have had this discussion.

Mr. Lyon: I would like to ask this be pointed out in the record. The reason I didn't limit my question to the one well was because their witness Shelley, whose deposition is in the record, gave this testimony, page 94 of his deposition—

"Q. Did you look into the tank? A. I think so, yes.

"Q. But you don't remember whether there was any oil on the surface of the acid or on the walls of the tank? A. Well, I just can't be absolutely sure about it. I just didn't have that in mind at the time. There probably was skim oil on it. You can hardly find a tank there isn't skim oil on it."

The Court: I will let him answer the question.

Mr. Lyon: Did Mr. Conner tell you anything about that subject at all or any of the other representatives of the Dow Company? A. As I remember at the time the samples were given to me no one mentioned the fact.

Q. Did they later? A. I learned later and I don't remember at the moment how, that that particular sample had received a treatment or processing which was different than that reported for the other samples. I did know that that sample was different but not at the time I got the samples.

Q. Well, you knew that the difference was in the fact

that there was a substantial amount of oil in the sample? A. I noticed that, yes.

Q. And are you prepared to state that there was no oil at all in other samples? A. No, I am not prepared to state that there was no oil.

Q. Did you make any test to determine whether or not, and if so in what quantity, the presence of oil would have any inhibiting effect on the acid? A. I don't recall that we have such data. We may have made some preliminary tests but I am not certain. We have not carried through any series of tests.

Mr. Lyon: Would it be all right to ask Dr. Cardwell if he knows there were any tests of that kind made?

Dr. Cardwell: I believe we did make some preliminary tests with oil.

Mr. Lyon: Well, I would like to know about those tests, what tests you made and what they showed. A. Well, we did not carry through on any of those tests because we were sufficiently occupied with the tests that we had under way.

Q. I would like to know what tests you did make on that subject and what the results were. As I understand from Dr. Cardwell there were some tests. Can you tell us what they were or refer to your records and tell us what they were? A. If I may see if I have anything in the record on that. (Witness conferred with Dr. Cardwell.) Some preliminary experiments were made using some of the oil that came on the sample that we have just referred to. Only a few preliminary tests were made.

May I have all of the question that was asked?

(Whereupon the question was read to the witness.)

A. Well, the results were of about this order. We did get an evidence of inhibition and the figures would be somewhere around 20 to 30% as the result of the use of that oil in the solution with the metal strips carried out just as we have described for the other experiments.

Q. Have you got your record or table on those tests here, either you or Dr. Cardwell? Can you produce the

data on those tests? A. I am sure they are not here. They were just preliminary experiments.

Q. Can you also send those to me along with this other item that I asked for? A. I will be glad to.

Q. I notice in these exhibits that you have produced here, these various tables refer to Series D, Series A, Series C, and so forth. I do not think that has been explained. I would like to have you tell us how many series there were in your tests which have these different letters from A to what? And tell us in each case what the particular series consists of? A. As referring to the metal? Q. Yes, I guess they refer to metal. On table VII, I see metal strips of strap iron, Series D; and in others you refer to Series C and Series A? A. Yes.

Q. I want to know how those series work out. A. The series would indicate batches of strap iron that were made up. If, for example, a certain number of pieces were to be cut from a given lot of strap iron, that batch would be referred to, for example, as Series A; and if some other batch of strap iron were used, that batch would be referred to as Series B; and another batch of strap iron would be referred to as Series C and so on.

Q. How many letters did you have in that series? A. The tables will indicate that. They will indicate that, just about. I note that we have a series as low as L, and it is presumable that we had approximately that many batches of strap iron.

Q. Each one of these series are for a batch of strap iron, or do those include this National Supply pipe, and all of this— A. Those numbers refer to strap iron only.

Q. Well, now, you made tests with each one of those different series A to L? A. Yes, sir.

Q. Well, now, first I would like to have you tell me, identify, if you can, as to what series A was, what Series B was, and what tests were made with each series? A. Well, that would be shown in the tables.

Q. Which tables? A. Well, in table I, for example, two series of irons were used. Series D for the first—for the

sample 8 Stella Wilcox, and sample 12-B from the Zahn well, with corresponding things.

Q. I understand that, but I want to know what different tests you made with series A. Haven't you got a schedule which would show? A. I would have no such schedule. It would be readily available.

Q. Could you make me up a schedule which shows each one of these series and shows each one of the tests made with those series? Can you do that and compare the data which you brought in, and filling the spaces would seem incomplete, because I will want to check into that? I don't see any reports here on Series K or Series E or Series F, and I want to know, because you evidently had a complete program here, and we only have tables covering part of the data, and I want to find out what the rest of the data is? A. Well, the rest of the data, it might be that some of the sets might have been small sets used for preliminary experiments.

Q. Well, I want to find out. A. Yes.

Q. You understand? A. We will be glad to try to get you the information, if we have the record covering it.

Q. All right. A. I am not sure we have the record covering series A to L complete, but I will see.

Q. Will you give me as complete a record as you can? A. Yes.

Mr. Lyon: Now, I have agreed with Mr. Owen to make this statement, Your Honor. Prior to last Saturday I asked him to furnish me certain material, particularly over the adjournment, and he has furnished me certain material, and I would want to state on the record what he has furnished me, so the record will show whether it was a compliance.

He sent me a table of the experimental data which was obtained in the acid corrosion tests as presented in and described in Table XIX, PX-167.

He also sent me a table of the experimental data which was obtained in the acid corrosion test with samples numbered 1 and 2 on the Stella Wilcox well.

He also sent me a table of the data obtained in the acid

corrosion test with the arsenic solutions prepared according to the disclosures on page 2, lines 74 to 78 of the Grebe and Sanford patent in suit.

And he also sent me a statement of the approximate dates on which the acid solution tests were made. I believe that is all you did send, Doctor. A. As I recall, and as I recall that was all that was requested.

Q. (By Mr. Lyon): I don't have in mind anything that you omitted? A. Yes.

Mr. Owen: Your Honor requested that a table be made showing the dates of purchase of commercial hydrochloric acid by the defendant and placed in its storage tanks at Mt. Pleasant, and of the different well treatments and taking of samples, and so forth, and I have prepared a chronological schedule here which will give you that information. I have given a copy of it to defendant's counsel.

The Court: That is what I want. Do you want to have that marked as an exhibit? It might be useful for somebody else. I am not asking it be done.

Mr. Owen: I think it might be marked as PX-172.

(The document above described was thereupon marked PX-172.)

REDIRECT EXAMINATION

Mr. Owen: Doctor, a considerable amount of cross examination referred to the percentages called for by the patent and included in those questions was one relating to what would be a relatively small amount of a corrosion inhibitor. In that connection I call your attention to a statement on page 1 of the patent, beginning in line 84, as follows: "The amount of arsenic compound added may be varied, but we have found that from 1 to 5 per cent thereof, based upon the weight of the solution will be satisfactory for the purpose." In view of that statement I will ask you what you understand the term relatively small amount to mean, that is, relative to what? A. Relative to the weight of the solution, strictly speaking.

Q. I will ask you if the amounts of lead, copper and iron you found in the defendant's solutions were relatively small amounts with respect to the weight of the solutions? A. They were.

Q. Now, how about the amounts of acridine, aniline, pyridine and quinoline, which you stated you had tested, being in some instances 1 per cent, and in other instances 3 per cent, and in other instances 5 per cent; do those refer to the percentages of the weights of the total solutions? A. That is right.

Q. In connection with your testimony regarding the testing of a 15 per cent hydrochloric acid solution containing 1 per cent of aniline—which you stated gave a 34 per cent reduction in corrosiveness—that is correct, is it not? A. That figure is correct.

Q. Now, will you tell the court how much more corrosive that solution containing 1 per cent of aniline was than the defendant's solutions which you have stated were 47 per cent inhibited; that is, how many times more corrosive. I will ask you, was the solution containing 1 per cent of aniline, than the defendant's solution, which gave 47 per cent reduction in corrosiveness? A. Why, in the ratio of 66 to 53; that is to say, the solution containing the 1 per cent solution of aniline had a corrosiveness of 66, in relation to the defendant's acid, which would have a corrosive value of 53, so that would be the ratio of the corrosiveness.

Q. How many or how much is that in times, one and a half, one and three-quarters, one and a quarter, or what?

The Court: Which one to the other?

Q. I want to know how many times more corrosive the aniline solution was than the defendant's solution. A. A little less than one and a quarter.

Q. Now, would you consider that solution which you made containing one per cent of aniline to be within the disclosure of the Grebe-Sanford patent? A. I believe it is.

Q. How many times as corrosive was that one per cent aniline solution as was the solution which was made up in accordance with the patent example, and which you stated was 97 per cent inhibited? A. If my figures are right, in

the neighborhood of the ratio of 66 to 3, or the corrosiveness of the one per cent aniline solution was about 22 times that of the arsenic solution referred to in the patent.

Q. Well, referring now to the solution you made up using acridine, and which I believe you stated reduced the corrosiveness of the acid 41 per cent, what would be the relative corrosiveness of that solution as compared with the defendant's solutions, taking them to be 47 per cent inhibited? A. The corrosiveness would be the ratio of 59 to 53. In other words, the corrosiveness of the acridine solution would be a little greater than that of the other solution referred to.

Q. Now, you stated, I believe, that that acridine solution was a saturated solution? A. That is right.

Q. By that, I understand that it took up all the acridine that the acid would dissolve? A. Yes; that is right.

Q. So that using that particular inhibitor, am I correct in stating that you could not get more than 41 per cent inhibition, according to your test? A. With our tests as conducted, at the temperature, constant temperature and all, one wouldn't expect to get much more reduction in corrosiveness with more acridine. It would not be in true solution, unless the suspended acridine might deposit on the plate, why, that would be the limiting value.

Mr. Lyon: I don't think the record shows what per cent of acridine went into solution in that test. May I ask? A. I recall we tried to make a one per cent solution, and it didn't quite all dissolve, so the answer would be the solution was somewhat less than one per cent.

Q. Mr. Owen: And I believe you have testified that the specific patent example using arsenic as the inhibitor contained only four-tenths of one per cent arsenic? A. Yes; this is right.

Q. Now, referring to your test using 1% of pyridine, your figure in that connection was 47% reduction in corrosiveness, as I recall. A. That is right.

Q. That is the same in that respect as the figure which

we have been taking for the reduction in corrosiveness of the defendant's sample, is it not? A. Yes, it happens to be of the same value.

Mr. Owen: I will state in this connection, Your Honor, I am adopting the 47% counsel for defendant used, not with the intention of being limited to that, because some of the tests show a much higher reduction.

Q. Then your solution containing 1% of pyridine would bear the same relation in rate of corrosiveness to the patent example using arsenic as the defendant's acids bear to the patent example? A. That is right.

Q. Now, taking up your test in which you used 3% of aniline and secured a 60% reduction in corrosiveness, how much more corrosive is the defendant's acid based on the 47% figure than the solution containing the 3% of aniline? A. The ratio would be as 53 is to 40 or the defendant's acid would be about 1.3% more corrosive.

Q. You stated that the defendant's acid at 47% reduction in corrosiveness would be about 1.3% more corrosive than the 3% solution of aniline, is that correct? A. That is right. The ratio would be as 53 is to 40, or about 1.3.

Q. Stating it another way, the 3% aniline solution would be about three-fourths as corrosive as the defendant's acid, or .7? A. Approximately so, yes.

Q. And how much more corrosive was that 3% aniline solution than the solution you made up in accordance with the patent example using arsenic? A. The arsenic gave a corrosiveness which could be expressed as 3% against this 3% solution of aniline, having a corrosiveness of 40%, so the ratio of the corrosiveness effect would be as 3 is to 40.

Q. Or the aniline solution would be about 13 times as corrosive as the arsenic solution, is that correct? A. That is right.

Q. Then your 5 per cent pyridine solution gave 65 per cent reduction in corrosiveness, and your 5 per cent aniline solution 67 per cent reduction in corrosiveness? A. That is right.

Q. Without asking you to make those computations I will simply ask if those two solutions were not still less corrosive than the defendant's solutions, that is, less in comparison with the ones I have previously referred to—well, that is a pretty complicated question.

The Court: It is 33. It is less than 40 and less than 66.

Mr. Owen: Yes.

Q. Then I will pass on down to the quinoline solutions. You made up three quinoline solutions, one containing 1 per cent of quinoline, one 3 per cent and one 5 per cent? A. That is right.

Q. And according to my figures each one of those gave 84 per cent reduction in corrosiveness? A. That is right.

Q. Now, how many times more corrosive were the defendant's acids than these quinoline solutions? A. About 3.3 times as corrosive.

Q. And how much more corrosive were the quinoline solutions than were the patent example solutions using arsenic? A. Approximately five times.

Q. So that here you have these quinoline examples five times as corrosive as the arsenic example of the patent, and still considerably less corrosive than the defendant's samples? A. That is true, assuming the defendant's sample has a reduction in corrosiveness of 47 per cent.

Mr. Owen: Now, the only other exhibits I want to offer are two sets of tables that Dr. Bartell furnished to Mr. Lyon, at his request, and I would like to offer this set in connection with the copy of Dr. Bartell's letter to Mr. Lyon dated August 4th, which states:

"Acting upon your request I am sending you herewith the experimental data which was obtained in our acid corrosion tests with samples numbered 1 and 2 from the Stella Wilcox well." I will offer that carbon copy of the letter and the four sheets of data as PX-247.

(Whereupon the document above referred was marked PX-247 by the reporter.)

Mr. Owen: I offer as PX-248 carbon copy of the letter written by Dr. Bartell to Mr. Lyon August 4th, reading as follows:

"Acting upon your request I am sending you herewith the experimental data which was obtained in our acid corrosion tests as presented in and described in our Table XIX (PX-167)," and attached to that copy are three sheets of data.

(Whereupon the document above referred to was marked PX-248 by the Reporter.)

Mr. Owen: Doctor, have you recently made corrosion tests on a number of commercial acids? A. Yes, we have.

Q. Where did you obtain the acids? A. The acids were obtained from the Dow Chemical Company.

Mr. Owen: I will state for the record, Mr. Lyon, that these samples were either telegraphed for, or written for, by Mr. Crawford. Mr. Crawford either personally, or someone under his direction, wrote or wired to these various chemical companies, asking them to send one and two gallon samples of their commercial hydrochloric acid, and as those samples came into the Dow Chemical Company, they were sent down to Dr. Bartell, without being opened. That is the way they came to you, is that right, doctor? A. Yes.

Q. And you opened them and made tests of them? A. Yes.

Q. Now, will you state what samples you received and tested, and the results of the tests.

Mr. Lyon: Hasn't he got that all in a table here? Isn't that all tabulated here? Can't you offer this paper without him reading it?

Q. Mr. Owen: Have you a table showing the names of the companies from whom these samples were received, and the results of your tests? A. Yes, I have.

The table was offered and received as PX-358.

Q. Well, now, state, doctor, how you made these tests, that is what technique you followed? A. These tests were made in exactly the same manner that we had previously adopted as standard tests for making our acid corrosion tests. The metal used was strap iron cut to the size of one inch by one-eighth by three-sixteenths. The solutions were

not agitated. The experiments were carried out at 85 degrees Fahrenheit. The volume of the acid solution on test was 50 c.c., the same as before, and the time of the test was 16 hours. It will be noted that two series of strap iron were used. That was because in preparing strap iron for tests a limited number of pieces are available from any one series of strap iron and we made use of two series.

CROSS EXAMINATION

By Mr. Lyon: Q. Doctor, referring to these tests that you have listed on PX-358 produced today, these various tests on the corrosiveness of these samples of commercial hydrochloric acid, when were these made? A. The acids were obtained on the 26th of August and the tests have been made since that time. Within the last two weeks.

Q. And did you make an analysis of these various commercial hydrochloric acids referred to on this exhibit 358 to determine their copper, iron and lead content? A. No, we did not.

Q. Or either of those three metals? A. No.

CLERK'S COPY.

Vol. II

TRANSCRIPT OF RECORD

(Pages 501 to 988)

Supreme Court of the United States

OCTOBER TERM, 1944

No. 50

THE DOW CHEMICAL COMPANY, PETITIONER,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY

No. 61

HALLIBURTON OIL WELL CEMENTING COMPANY, PETITIONER,

vs.

THE DOW CHEMICAL COMPANY

ON WRITS OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SIXTH CIRCUIT

PETITIONS FOR CERTIORARI FILED { APRIL 6, 1944.
APRIL 17, 1944.

CERTIORARI GRANTED MAY 15, 1944.

Supreme Court of the United States

OCTOBER TERM, 1944

No. 50

THE DOW CHEMICAL COMPANY, a Corporation,
Petitioner,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY,
a Corporation,
Respondent.

TRANSCRIPT OF RECORD

On Petition for Writ of Certiorari to the United States Circuit Court of Appeals for the Sixth Circuit

Volume II—Pages 501 to 988

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IN THE

UNITED STATES CIRCUIT COURT OF APPEALS

FOR THE SIXTH CIRCUIT

No.....

THE DOW CHEMICAL COMPANY, A CORPORATION,
Plaintiff-Appellant,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY,
A CORPORATION,
Defendant-Appellee.

Appeal from the United States District Court for the Eastern District of Michigan, Northern Division

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143	Item in Oil City Derrick for October 28, 1895, reporting acid treatment of wells by Frasch and Van Dyke.....	1194A	1656
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145	Ditto, for January 15, 1896.....	1194A	1658
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181	Ditto re Run 2B. Similar to Run 1B, but with Series 2 tubing	517	1739
182	Ditto re Run 2D. Similar to Run 2B, but with different amounts of copper, lead and iron	517	1740
183	Ditto re Run 2E. Similar to Run 2B, but with different amounts of copper, lead and iron	517	1741
184	Prutton's summary and conclusions with respect to runs in Exhibits 176-183.	534	1742–45
185	Prutton Tables showing results of Runs 1M, 1N, 2M and 2N, using commercial acid from special tank embodying features of defendant's truck tanks	537	1746–49
	Sketch showing equipment used in Runs 1M, 1N, 2M and 2N	537	1751

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Exhibit Number		Pages Identified	Printed
186	Defendant's booklet re Howco method	587	Vol. II, 587
187	Prutton graph showing results of runs of Exhibits 176-183	602	1752
188	Prutton graph comparing results of Runs 1M, 1N, 2M and 2N (Exhibit 185) with average of Runs 1A, 1AA, 2A and 2C (Exhibits 176-179)	604	1753
189	Prutton graph showing results of tests of 15% c. p. hydrochloric acid with different added amounts of copper, lead and iron	605	1754
192	History of oil development in limestone fields prior to 1932 and history of acidizing in those fields beginning in 1932, prepared by the witness Fitzgerald	178	1755–70
195	Item from Montana Oil & Mining Journal for January 26, 1935, reporting increase of production in Pondera (Montana) field, due to acidizing	186	1770
196	Bulletin of Montana Oil Conservation Board	189	Vol. I, 187
199	Letter, Dow Co. to Oil Makers, 9-23-32.	1171	Vol. III, 1172
200	Letter, Grasselli to Oil Makers, 10-14-32.	1174	Vol. III, 1174
201	Letter, Grasselli to Oil Makers, 11-1-32.	1175	Vol. III, 1175
202	Letter, Grasselli to Oil Makers, 1-26-33.	1176	Vol. III, 1178
203	Letter, Grasselli to Oil Makers, 9-15-32.	1179	Vol. III, 1179
204	Letter, Oil Makers to Grasselli, 10-8-32.	1179	Vol. III, 1180
205	Oil Makers checks to Penn. Salt Co.	1196	Vol. III, 1196
216	Letter, Lee to Oil Makers, 2-7-33	1243	Vol. III, 1242
218A-218D	Pages from notebook kept by the witness Sprenger	1257	1772–74
219, 220	Photograph of standing valve and working valve	1268	1775
228	Letter, Prutton to Rebbeck, 1-28-41	799	1776
231A-231J	Dow Company's records of shipments of acid to Pure Oil Company during period from February to May, inclusive, 1932	140	1777–86
232	Table supplementing Exhibit 94	845	1787
233	Summary of well treatments made by licensees of Dow other than Dowell	845	1788

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Exhibit Number		Pages Identified	Printed
234	Sketch and data prepared by Dr. Prutton showing rates of attack on oil well tubing of 15% c. p. hydrochloric acid and of 15% synthetic defendant's treating acid	840	1789
242	Dowell advertisement in Petroleum World, September, 1938	846	1790
243	Ditto for January, 1939	847	1791
245	Dowell, Inc., Service Price Schedule 110.	852	1792
246	Record of shipments of hydrochloric acid and arsenic inhibitor by Dow Company for period January to June, 1932, inclusive	121	1793
305	Affidavit of Robert Quinlan on the first treatment of a Pure Oil Company well with inhibited hydrochloric acid	1028	1794
328	Table showing results of acid treatments of gas wells by Dowell, Inc., prepared by the witness Lyons	191	1796
329	Ditto, showing additional treatments and data	193	1797
330	Table showing time acid was in tubing in each of 122 acid treatments made by Dowell in Kansas from March to September, 1936, in 97 consecutive Arbuckle dolomite wells	197	1798
331	Data showing average time acid was in tubing in making the 122 treatments itemized in Exhibit 330	197	1799
337	Chart showing combinations possible under claims of Gravell Patent 1,678,775.	1320	1800
343	Alquist Table showing rate of corrosion of mild steel in various concentrations of hydrochloric acid	1365	1801
	Charts forming part of Exhibit 343	1365	1802–03
344	Alquist Table showing acceleration of the rate of corrosion of hydrochloric acid containing an acid regulator caused by the addition of tin, cobalt or nickel	1370	1804
	Chart forming part of Exhibit 344	1370	1805
347	Table supplementing Plaintiff's Exhibit 252	1404	1806
348	Table showing treatments by Dow licensees other than Dowell	1404	1807

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Exhibit Number		Pages Identified	Printed
349	Table showing summary of royalty charged by Dow Company to licensees.	1404	1808
350	Table showing quantities of inhibited acid and other materials used by Dowell, Inc.	1405	1809
350A	Graph illustrating data in Exhibit 350.	1407	1810
351	Acidizing orders, tickets and other data from defendant's files relating to wells at which plaintiff secured samples of defendant's truck (treating) acids	1406	1811–24
354	Dowell advertising data for years 1932 to 1934	1407	1825
355	Photograph of one-half gallon container used in Alquist's tests, and table and graphs showing results of tests.	1376	1827–29
356	Photographs of 10-gallon drum and of equipment used by Alquist in making tests, and tables and graphs showing results of such tests	1380	1830–40
357	Table, graphs and drawing of equipment used by Alquist in making tests showing loss of strength of 15% hydrochloric acid when in contact with iron for different periods up to 24 hours.	1398	1841–46
358	Bartell Table showing summary of corrosion tests of various commercial hydrochloric acids of 15.1% strength..	499	1847
360	Table showing Dowell advertising 1932 to 1940, inclusive	1408	1848
362	Poffenberger's report on acid treatment of Dow Company's brine well No. 77	1418	1849–53
363	Poffenberger's report on acid treatment of Dow Company's brine well No. 80	1418	1854
364	Poffenberger's report on tests of inhibiting value of arsenic compounds in hydrochloric acid	1423	1855
366	Carr and Humphrey patent application for method for increasing fluid production from oil wells	1427	1857–64

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Number Exhibit		Identified	Printed Pages
367	Carr and Humphrey patent application on chemical reagent for use in oil wells	1428	1864–68
368	Carr and Humphrey patent application for method for introducing acid reagents into oil wells by gas pressures	1428	1868–72
369	Agreement between The Dow Chemical Company and The Pure Oil Company dated January 31, 1933	1428	1873–77
370	Agreement between The Dow Chemical Company and The Pure Oil Company dated June 30, 1934	1428	1877–82

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8	Excerpts from article by R. Van A. Mills, dated December, 1923, entitled "The Paraffin Problem in Oil Wells".	35	1883
72	Letter from M. G. Harper to J. W. Van Dyke, dated December 5, 1895	1033	1884
73	Telegram, Harmon to Van Dyke, dated January 24, 1896	1033	1885
74	Memo from C. F. Lufkin to Van Dyke, undated.	1033	1886
83	Telegram, J. C. Donnell to Van Dyke, dated November 25, 1895		1887
86	Telegram, Harper to Van Dyke, dated December 6, 1895		1887
88	Letter, The Grasselli Chemical Company to Van Dyke, dated July 26, 1895		1888
90	Letter, Herman (Frasch) to Van Dyke, dated September 22, 1895		1889
101	Letter, Harper to Van Dyke, dated December 16, 1895	1033	1890
102	Letter, Harper to Van Dyke, dated December 16, 1895	1047	1891
103	Letter, Ohio Rubber Company to Solar Refining Co., dated September 21, 1895.	1047	1892
104	Letter, Ohio Rubber Company to Solar Refining Co., dated September 25, 1895.		1893
105	Memo re Crossley Well No. 3 of Ohio Oil Company	1047	1894

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Exhibit Number		Pages Identified	Printed
108	Letter, Harper to Van Dyke, dated February 5, 1896	1047	1895
109	Correspondence between Lufkin, Van Dyke and Donnell re acid treatments (July, 1895, and February, 1896)	1047	1896
110	Letter, Lufkin to Van Dyke, dated July 29, 1895		1900
111	Letter, Harper to Van Dyke, dated December 2, 1895	1047	1902
112	Letter, Grasselli Chemical Company to Van Dyke, dated November 21, 1895		1903
113	Letter, Van Dyke to Grasselli Chemical Co., dated November 20, 1895		1904
114	Memo dated November 21, 1895		1905
115	Letter, Frasch to Van Dyke, undated		1905
132	Letter, Grasselli Chemical Co. to Van Dyke, dated July 19, 1895		1906
138	Letter, Lufkin to Van Dyke, dated August 2, 1895		1907
151	Report on scale formation in wells by Blaine B. Wescott	1081	1908–21
152	Report by F. W. Karl, dated February 1, 1929, re treatment of William Berryhill Well No. 8	1087	1922
153	Same as Plaintiff's Exhibit 153	1087	1664–1704
191	Gardner Affidavit	750	Vol. II, 752
221	Letter, Robinson to Prutton, 9-12-39	769	Vol. II, 769
222	Letter, Rebbeck to Prutton, 1-24-41	771	Vol. II, 772
223	Letter, Prutton to Rebbeck, 2-19-41	774	Vol. II, 775
224	Letter, Rebbeck to Prutton, 7-10-41	791	Vol. II, 791
225	Letter, Rebbeck to Prutton, 7-9-41	792	Vol. II, 791
226	Letter, Rebbeck to Prutton, 7-9-41	792	Vol. II, 793
227	Letter, Rebbeck to Prutton, 7-11-41	792	Vol. II, 793
280	Hathorn's chart re tests on hard steel tank No. 1	854	1924
281	Hathorn's chart re tests on hard steel tank No. 2	854	1925
282	Hathorn's chart re tests on hard steel tank No. 3	854	1926
283	Hathorn's chart re tests on soft steel tank No. 4	854	1927
284	Hathorn's chart re tests on soft steel tank No. 5	854	1928
285	Hathorn's chart re tests on hard steel tank No. 1	854	1929
286	Hathorn's chart re tests on soft steel tank No. 4	854	1930

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Exhibit Number		Pages Identified	Printed
287	Index for Hathorn's corrosion experiments	855	1931
288	Photograph of Hathorn's hard steel tank No. 1	855	1932
289	Photograph of Hathorn's soft steel tank No. 4	855	1933
294	Prior art patents	912	1935–88
	Frasch 556,669	68	1935
	Laverty 856,644	913	1939
	Beneker 914,916	915	1941
	Gravell 1,398,507		1943
	Holmes 1,470,225	916	1945
	Gravell 1,678,775	95, 897	1947
	Gravell and Douty 1,678,776		1950
	Fischer et al. 1,736,282	917	1954
	Rhodes 1,746,677	918	1957
	Rhodes 1,746,678	920	1961
	Vignos 1,750,651	920	1964
	Harrison 1,766,902	921	1968
	Corson et al. 1,773,953	921	1971
	Lawrence 1,780,594	922	1974
	Lawrence 1,780,595		1976
	Calcott 1,785,513	923	1978
	Burke 1,789,805	923	1980
	Corson 1,809,621	923	1985
	Carr 1,891,667	76	1988
300	Memorandum given by Grebe to defendant's witness Thomas	1012	1993
301	Letter, C. Plummer to The Dow Chemical Company, dated December 1, 1932	1016	1994–97
302	Memorandum of conversation with Ross T. Sanford, dated December 8, 1932.	1016	1998–99
303	Memorandum of conversation with John J. Grebe, dated December 8, 1932.	1023	2000–02
304	Preliminary draft of patent application of John J. Grebe, dated June 7, 1932.	1025	2002–09
312	File history of Grebe and Sanford patent 1,877,504		2010–46
314	Conception data sheet signed by John J. Grebe July 2, 1932		2047

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DR. CARL F. PRUTTON,

a witness called on behalf of Plaintiff, testified as follows:

DIRECT EXAMINATION

My name is Carl F. Prutton. My residence is 2217 South Overlook Road, Cleveland Heights, Ohio. My occupation is professor in charge of the chemistry and chemical engineering department, at Case School of Applied Science, in Cleveland, Ohio.

As to my education, I received the Bachelor of Science degree, the Master of Science degree, and Doctor of Philosophy. My experience in chemical matters has been connected with both my educational training and industrial experience as a consultant for many concerns. I have been connected with Case for twenty-one years. Electrochemistry is one of the subjects that I have taught for many years.

By Mr. Owen:

Q. Have you conducted any experiments with a view to ascertaining what effect the presence of small amounts of copper, lead and iron in hydrochloric acid solutions has on the corrosive effect of the acid on iron or steel? A. I conducted two sets of tests, to determine the effect of copper, lead and iron in hydrochloric acid solutions, upon oil well tubing. The first set of tests was conducted upon a small laboratory scale; the second series of tests was conducted on a large piping set up, in which large volumes of prepared acids were run through the system. The tests were conducted in the laboratories of the Case School of Applied Science during the last two years, or two and a half years.

The small scale tests were performed in the following manner: One inch sections of 1¼ inch type C oil well tubing were cleaned under an exact procedure of cleaning, following the following steps: First, the small sections of

tubing were washed thoroughly with a fifty-fifty mixture of benzene and acetone. Second, immersed in 15 per cent c.c. hydrochloric acid for one hour. Third, rinsed thoroughly in water. Fourth, dried in an oven at 105 degrees Centigrade for one or two minutes, simply to remove the moisture.

The ends of the samples were then carefully faced off in a lathe. The handling of the sample in that operation was done avoiding any contact of extraneous material, handling with metallic tongs, and there was no oil used in the cutting operation. In this manner an exact length of oil well tubing could be obtained.

The sixth step was to brush the inside surface of the tubing with a hardened steel wire brush, known as a flue cleaning brush, which removed any loose particles of metal from the inner surface of the sample. The outside of the sample was burnished on a clean wire burnishing wheel, to remove any loose particles. The seventh step was, the sample was then rinsed in acetone, and then dried in an oven at 105 degrees Centigrade for about one minute, and then cooled in a dessicator, and weighed.

The test procedure was to take these small sections of oil well tubing which had been cleaned in the manner that I just described, and suspended them after, of course determining their initial weight, suspended them in a two liter bottle by means of a glass hook coming through the top of the bottle in the middle of the sample of acid on which the corrosiveness was to be determined. 1360 c.c. of acid were placed in the bottle. The bottle was immersed in a constant temperature bath at 30° C. and when the acid in the bottle had reached the 30° C. temperature the steel sample was then inserted and the test was started. The sample was removed at the end of the three-hour period, was washed with water, then with acetone, and then quickly dried and final weight of the sample determined. The loss in weight from the specimen was then calculated by subtracting the two weights—the difference between the initial and the final weights.

The results of these tests were reported in two figures. First, the grams of steel dissolved per square meter of area of the sample per hour of acid contact; and secondly in terms of the percentage reduction in corrosiveness when a given sample of acid was compared with chemically pure acid, exactly in the same manner calculation that Dr. Bartell used in expressing his results.

Q. What acids did you use in these small scale tests? A. The acids that were used in the small scale tests, first, a determination was made upon chemically pure acid which was diluted to 15% concentration and, of course, the results of that test expressed on the basis of percentage reduced corrosiveness would be zero because it was the blank run. Samples were then prepared from 15% chemically pure acid, which contained various amounts of copper chloride, of lead chloride, and of iron chloride. The chemically pure salts were dissolved in the acid in definite proportions to give a range of compositions that covered the range of compositions reported to us as having been found by Dr. Bartell in his analyses of the defendant's samples obtained in the acidizing of oil wells.

The second test following the blank, the acid contained 15% hydrochloric acid, 473 parts per million of iron in the form of iron chloride, 242 parts per million of lead, and 2.14 parts per million of copper. The percentage reduction in corrosiveness of that acid as compared with the C. P. was 59.7.

The third sample, 15% hydrochloric acid contained 473 parts per million of iron, 242 parts per million of lead, and 3.72 parts per million of copper. The percentage reduction in corrosiveness of that acid as compared with the C. P. was 70.

The fourth sample contained 15% hydrochloric acid, again 473 parts per million of iron, 510 parts per million of lead, and 1.86 parts per million of copper. Percentage of reduction in corrosiveness as compared with the C. P. acid was 62.8.

The fifth sample contained 15% hydrochloric acid, by

weight 473 parts per million of iron, 510 parts per million of lead, and 4.18 parts per million of copper. The reduction in percentage of corrosiveness was 71.4.

The sixth sample containing 1430 parts per million of iron, 204 parts per million of lead, and 1.86 parts per million of copper, the percentage reduction in corrosiveness was 61.1.

The seventh sample, 15 per cent HCl, 1440 parts per million of iron, 530 parts per million of lead, and 3.44 parts per million of copper, 70.5 per cent reduction in corrosiveness.

The samples were all run in duplicate and the individual determinations did not vary over one per cent from each other, and the average is reported.

The conclusions from these tests are that copper chloride and lead chloride and iron chloride in the compositions such as reported to me as having been found by Dr. Bartell in the defendant's acids, reduce greatly the corrosive effect of the acid upon oil well tubing, and the reduction is around 70 per cent in this laboratory test. We have made some other tests in which the proportions have been varied somewhat from these figures, but the percentage of inhibition does not change greatly from these.

Q. Well, then, will you compare the results of the different tests you have made, six in number, as compared with the C. P. hydrochloric acid blank, and explain how the effect of varying the amounts or the proportions of iron, lead and copper have affected the corrosiveness of the solution? A. Well, these results would indicate quite definitely that iron has practically a negligible effect in the concentrations that were used here, and if you will look at Test 2, in which 473 parts per million of iron were used and about 240 of lead and a little over 2 of copper, it was 59.7% reduced in corrosiveness. And when the iron was stepped up in Test 6, to 1430 parts per million and the lead was about the same, 204 instead of 242, and the copper was around 2 parts per million, the percentage corrosiveness reduced was 61.1, or substantially the same. In other words, the iron,

variation in iron concentration over this range of about 470 parts per million to over 1400, the iron has practically no effect upon the amount of inhibition that is obtained.

With the copper, why, you can see a definite increase in going from Test 2, where 473 parts per million of iron were present and 242 of lead, but only 2.14 of copper gave 59.7 per cent reduction in corrosiveness. In Test 3, when the iron and lead contents were identical and the copper content stepped up to 3.72, or not quite double that in Test 2, the percentage of inhibition went up, or the percentage reduction in corrosiveness went up to 70 per cent. In other words, doubling the copper content from 2 parts per million, approximately, to 4 parts per million, increased the inhibition about 10 per cent.

The lead concentration, if you try to analyze it, it shows some slight increase in inhibitive power, but not nearly as great as the copper, so the iron has practically no effect, the lead has some effect and copper has a very appreciable effect, which agrees with Dr. Bartell's tests.

Mr. Owen: I supposed I had a table showing what the Doctor has been testifying to, and which I intended to offer, but it is apparently not available today. I would like to offer it tomorrow morning.

The Court: You may do that. I want to have it as an exhibit. I will give you a number now. It will be PX-173.

(Plaintiff's Exhibit No. 173 was reserved.)

Mr. Owen: You referred to another series of tests which you conducted, more or less approximating conditions which are present in acidizing an oil well. Will you describe those tests and the apparatus and materials you used in making them? A. In the large scale tests we used this pipe "C" oil well tubing, which we purchased from the Oil Well Supply Company of Pittsburgh, Pennsylvania. There are a number of charts and figures. I don't know which ones you want to introduce in evidence.

Mr. Owen: Let us use PX-174 for the drawing showing the apparatus which you used in your tests, and which you are now going to describe.

The Court: PX-174 will show this larger experiment, is that it? I am thinking of it as the bigger one.

Mr. Owen: Yes. Now, will you describe the apparatus and the materials, and the manner in which you conducted those large scale tests? A. The apparatus employed was, first, as shown in Figure 2 (PX-174) in this report that I have. In these large scale tests, approximately 200 gallons of 15 per cent hydrochloric acid were run through 112 feet of this 1½ inch oil well tubing—15 per cent commercial hydrochloric acid, and 15 per cent commercial hydrochloric acid to which various metal concentrations were added. The acid was all purchased from the Grasselli Division of the du Pont Company, in Cleveland, and it was regular commercial hydrochloric acid, or muriatic acid, delivered in carboys, and we transferred the acid from the carboys through glass siphon tubes into a stoneware storage crock, and diluted the acid with Cleveland city tap water to the correct concentration of 15 per cent.

Q. The stoneware crock is the one shown in the photograph, PX-175? A. Yes. The stoneware crock used was a brand new stoneware crock, obtained from the Myers-Knight Company, of Akron, and was thoroughly soaked in hydrochloric acid for several days before using it in tests, and between tests was soaked in 15 per cent hydrochloric acid to be sure that there was no contamination from one test to another.

The acid was prepared in that crock, and drained from the bottom of the crock through the spigot into the piping system, and connections were made between the piping system and the stoneware crock by means of pure gum rubber tubing, short lengths, and short lengths of 1 inch Pyrex tubing.

The Court: Is that the part that is the top of the tubing? A. Yes, the top of the tubing. Part Y is the start of the steel tubing. The line connecting to the crock from point Y back to the crock and the line extending up to the top of the crock is all Pyrex tubing, connected with short lengths of rubber tubing whereever connections had to

be made. All of the rubber connections that were used in this work were soaked in hydrochloric acid for several days to make certain no soluble constituents of the rubber tubing would dissolve into the acid on the actual test.

The entire line of tubing was made up of 20-foot sections of this oil well tubing connected together with couplings of the same tubing. The couplings were supplied with the tubing when we purchased it. And elbows were prepared by cutting the threaded ends off of several lengths of the tubing and welding those short sections together to make elbows with threads on them. That length of 1¼" oil well tubing, extending for a total distance of 112 feet, was slightly inclined so the acid would run through it. I think the fall from one end to the other was about six to eight feet in the 100 foot length.

The Court: That is not shown. A. No, this is just a schematic drawing. It was on a slight incline. At the lower end of the oil well tubing, the discharge end, a rubber stopper was inserted into the last length of oil well tubing and through that a short length of 1" diameter Pyrex tubing, and under that a short length of pure gum rubber tubing. Extending beyond that rubber tubing was another short length of Pyrex tubing that dipped into the top of an open bottle. On this rubber tubing we had a screw clamp so we could adjust the rate the acid ran out of that piping system. The bottle had an orifice in the bottom, this discharge bottle that the acid ran into of one-gallon capacity, and by keeping the height of the acid in the bottle at a definite level with this definite diameter orifice at the bottom, the rate of discharge was maintained constant at one gallon per minute, with a definite size hole in the bottom of the bottle, side of the bottle, and a definite liquid in that open bottle running into this tube you get a definite rate of flow. It is a standard method of measuring the flow. The rate of these tests was adjusted to one gallon of acid per minute.

The Court: Your final adjustment was by the size of the stream? A. By the size of the stream, by the height

of the liquid column. The higher that liquid would be in the bottle the greater the run out of the hole in the bottom. In other words, we had a constant size orifice.

The Court: The adjustment was by the size? A. By the size, by the screw clamp. The size of the stream was adjusted so that we maintained a definite calibrated level at the bottom. At the top of this system connecting to the Pyrex tubing leaving the crock was a gas vent which permitted the escape of any hydrogen gas from the system. It would simply bubble back up the tube and out of the Pyrex tubing vent at X. We discharged that back into the top of the crock because sometimes the bubbles of hydrogen carry small amounts of acid with it, a little slug of acid would be shot out.

The Court: How did you get it back? A. We just bent the tube over the edge, up over the edge. These tests were run at 85 degrees Fahrenheit. All of the tests were run after the acid was adjusted to 85 degrees Fahrenheit. The results of the tests and the data taken are given in individual tables that have been prepared, and if we take up the first test that was made—before I take up this first test I think it would be well to describe the method of cleaning out this tubing.

The Court: Right in this same book? A. It is described in there, all the methods that we used. It is the first stiff sheet of tabular data there, marked Table I.

The Court: I was wondering if you wanted the whole thing in. It seems like a very carefully worked out and prepared document. I was wondering if you wanted this as an exhibit. I am not trying to outline your course of procedure. I thought before we started using up letters I would ask you whether you wanted it all in. You have got minutes on this one.

Mr. Owen: I have got minutes on this. This is my copy and I have marked it up. Let us consider this tonight.

The Court: Suppose we call Table I Exhibit PX-176. And when we get one that you can spare and want to we

will put it in. I will save you the place. Table I is PX-176.

(Plaintiff's Exhibit No. 176 was reserved.)

The Witness: The method of cleaning the tubing was substantially the same as was used in cleaning these small specimens that I described in the laboratory test. The first cleaning operation was the washing of the tubing with a solvent, acetone benzene, to get grease and paint and oil off the outside and inside of the tubing, and then the tubing was pickled with hydrochloric acid inside, fifteen per cent, and then washed thoroughly and then reamed out or brushed out with this very stiff flue brush, which was kept very clean and we used a new one on about every second test to remove any very loose particles of metal that may have been on the inside of the pipe.

And the inside of the pipe, when that cleaning operation was over, had a burnished appearance. It was very bright looking, very clean. The outside of the pipe in these tests was not wire brushed as we did in the laboratory test, simple because the outside of the pipe was not exposed to the acid in the large scale tests, but in the small scale tests it was exposed. So we did not give it the same cleaning on the outside.

The tubes and fittings were all accurately weighed, and the accuracy of the weighings was to about two grams, and so we could determine the loss in weight of each fitting and each length of tubing in the test. And the pipes were then carefully assembled, after the cleaning operation and weighing.

The acid was run through the pipe system after it reached a temperature of 85 degrees Fahrenheit, and the rate was adjusted rapidly to one gallon per minute. That was easily done. It occupied a very short time. And then, as the acid ran through the tubing, we took periodical samples of the discharged acid leaving the tubing and saved those samples for analysis and future examination.

At the end of the test, the tubing was taken out and washed, cleaned and re-weighed, dried, of course, and re-weighed to get the loss in weight or a rough check on the

loss in weight, but the amount of iron that was picked up by the acid was determined very accurately by analysis of the inlet acid and analysis of the outlet acid during the run.

Now, if we go to Table I, the first run was made using 15 per cent hydrochloric acid, prepared from this Grasselli commercial acid, diluted with Cleveland tap water. Run 1-A, the first column gives the run numbers. The second column gives the general conditions of tests and of the acid used, 15 per cent hydrochloric acid directly from the stoneware crock through the tubing, temperature of 85 degrees Fahrenheit, at the rate of one gallon per minute, and the Series 1 tubing.

Now, in order to insure that we had made a valid test, we simply picked at random five lengths of this oil well tubing, numbered them carefully and called that Series 1 tubing, and every test in which Series 1 tubing is used has the number 1 in front of it. So 1-A was run with Series 1 tubing. We then picked five other lengths of oil well tubing at random and numbered each length and called those tubes Series 2 tubing, and so every test run upon Series 2 tubing has the number 2 in front of it and the letter following. It is a different tubing. So we ran the 15 per cent commercial acid, 1-A is running 15 per cent commercial acid through Series 1 tubing, and then we took this other set of tubing, completely different, and we ran commercial acid through it. So we have two separate, completely separate sets of tubing, and we kept those sets together in the subsequent runs.

The first run, 1-A, shows a run with the commercial acid diluted to 15 per cent concentration, temperature 85 degrees Fahrenheit, and in the third column in this table are the gallons of acid through the tubing between samples.

Now, we took a sample about every 20 minutes, of the effluent acid, and at that time, at the time of taking the sample of effluent, we determined the number of gallons of acid that had run through the system by noting the fall of level of acid in the crock. We could calculate the amount that had gone through. So at the time that 27½ gallons

of acid had run through the tubing, if you follow over you will see that the sample No. 1, in the samples taken at the outlet, is opposite that particular volume of acid that was discharged, and so every 20 minutes we took a sample of the discharged acid.

At the start of the test, each of these tests, the first gallon of acid that came through was distinctly dark. It had a darker color than the rest of the acid, and we found in each case the initial acid that came through, the first gallon, definitely contained a greater amount of iron than the rest of the acid taken at subsequent times. But that concentration of iron in that first gallon, although it was high, was not an appreciable part of the total iron dissolved. It was a very negligible part, and we have shown in these tables, just to make them complete, we have shown the concentration in that first gallon of acid.

The Court: Now, that acid you took where? A. We took it down at the bottom. It just ran out of the bottom through the whole piping system.

The Court: All through the pipes? A. Yes, and we took a sample out of the first gallon of acid coming through, which was a little darker than the rest. After that it cleared up and got a certain definite yellow color, due to the iron, and our iron analysis fell down to a fairly stable value, and we took a sample every twenty minutes of the discharged acid, and we took two samples, as shown in the fourth column under the general heading of samples taken at the inlet, the fourth major volumn, samples taken at the inlet.

The Court: That is way up at the top? A. At the crock. We took two samples, one at the start of the run and the other at about half way through the run. Those two samples were blended together to make a composite sample, composition of the acid leaving the crock, just to save analysis.

The Court: You didn't analyze that? A. We did not analyze each separately. We mixed the two together. We took an equal volume of each.

The Court: I took it from what you said this is in the

initial test? A. In the crock. They should be just alike. There was no necessity of checking each one. The composition of that inlet acid is shown in this sub-head, specimen Fe, under the fourth column of samples taken at the inlet, and the next column with the sample number.

The Court: 9.3 parts iron to a million parts of acid? A. Parts of acid.

The Court: Of the whole solution? A. That is correct. Now, under samples taken at the outlet, the first sub-column and sample number, the initial sample out, that was the first gallon of acid coming through, was slightly darker than the rest. Then a sample was taken at the end of twenty minutes and at twenty minute intervals thereafter. Those 20-minute samples were blended together to make composite samples.

The Court: Not the first one. A. The first one wasn't considered. We took one sample right at the start. The first gallon of acid through we took a sample. That is the initial out. No. 1 is the first sample taken at the end of the first twenty-minute interval. The initial out is the sample of the first gallon of acid that left the tubing.

The Court: Well, what is No. 1? A. No. 1 was taken at the end of twenty minutes, at the end of the run.

The Court: All right. Now I've got you. After that initial out you bunched three together. A. 1, 2, 3; then 4, 5, 6, and then 7, 8, 9 and 10 were bunched together in proportion to the volume that had run through the pipe at the time analysis was made for the iron content in those effluent samples or composite samples and the parts per million of iron is reported in the second sub-head under "Samples Taken." The initial sample out, 2240 parts per million of iron; the first composite sample of 1, 2 and 3, 1135 parts per million; the second composite sample 4, 5 and 6, 1450 parts per million; the third composite sample, 7, 8, 9 and 10, 1405 parts per million.

The Court: Now I am curious to know that there is a peculiar curve there. It is a way up and down, then up and then down. I am wondering if you had analyzed each one

of those samples whether you would get another little hump in there. A. The initial out is very easily explained. In the burnishing operation and cleaning there were little particles that dissolved rapidly so that shouldn't be considered. The subsequent, although there is some variation, the variation is not a great deal. I think particularly in the last two samples—1450 to 1405 is not a great deal, and the 1135 that, of course, is lower than the 1450.

The Court: What do you think No. 1 would be as compared to No. 3? A. Well, it might be 10% difference—something like that; maybe 100 parts per million.

The Court: One or three? A. I think No. 1 would be lower than No. 3, possibly.

The Court: In other words, you think that that first gallon out had gotten out all the loose stuff? A. All the loose material.

Mr. Owen: I might call your attention to the fact that in subsequent tables, II, IV and III, which were all run with commercial acids without any additions of metals, the same ratio or the same phenomenon appears in I, II and III. That is, the first initial out sample is high in iron and then the next three, the composite is lower than the second three, and the final four drops off a little from the second three of that sample that run through the series.

The Court: What you found was not free iron but ferrous what? A. Ferrous chloride.

Mr. Owen: Now, Doctor, explain the entry in the last column. A. The last column report is the number of grams of iron picked up by the acid in running through the tubing. The amount of iron at the inlet acid was calculated and the amount of iron at the exit was calculated and the difference shows an increase in iron content and it amounted to 1043 grams of iron or a little over two pounds of iron dissolved.

The Court: In other words, if you take this ferrous chloride and bring it up so you didn't get your free iron you would have two pounds? A. You would have two pounds of metallic iron. Ferrous chloride is $FeCl_2$. Now,

the second table, Table II in the first column, the run number is given as 1-AA, the "1" designating it as Series 1 tubing. The run 1-AA was a blank run of fifteen per cent commercial hydrochloric acid of the same type described in the first run, run on Series 1 tubing, and the conditions were exactly the same as in the first run. And in this case the initial crock acid contained four parts per million of iron, and the composite samples taken at the exit during the run, the initial out, was 3,540 parts per million. The first composite 1180, the second composite 1263, and the third composite 1218 parts per million of iron, making a total of 943 grams of iron dissolved in that particular test from the tubing.

Then in Table III we ran this diluted 15 per cent commercial acid through the second series of tubing, using entirely different tubing than Series 2 tubing, so in Table III we have run 2-A, "2" designating the series of tubing, and "A" designating a blank commercial fifteen per cent acid. The temperature, rate of flow and so forth was the same as in the other tests. The inlet iron concentration in the acid, the acid going in contained 9.3 parts per million of iron, and the samples of acid leaving the system, the initial out, 3,580 parts per million of iron, the first composite sample 1292 parts per million, the second composite sample 1357 parts per million of iron, and the third composite 967 parts per million. The total amount of iron dissolved from this tubing was 919 grams. Then on Table IV we have a duplicate blank run with a smaller amount of acid. This is run 2-C of Table IV. The 15 per cent acid was run through from the stoneware crock in the Series 2 tubing at 85 degrees Fahrenheit. The composite of the crock sample was 7 parts per million iron. The analysis of the two samples, the initial acid out, 1330 parts per million. The first composite sample, 1143 parts per million of iron. The second composite sample 1088 parts per million of iron. Third composite sample 1070 parts per million of iron. And the total amount of iron dissolved, 791 grams. So there are the results of four blank runs.

The Court: I don't consider it of any importance, because it is so small, but it does show that there was less than half as much iron in the crock in the sample in Table II. They got down to half. A. We had purchased several batches of acid, and it varied somewhat from the one shipment to another.

The Court: Each one of these acids are different purchases? A. No, not each one. I have a record of our purchases, and sometimes the purchases overlap the runs. We didn't run the same acid through two runs. We purchased several batches of acid from the Grasselli Company and if we had three or four carboys left over, we used those three or four and it possibly went into the next shipment.

The Court: It was so little I didn't consider it important. I didn't count it as being important. And yet I was curious if it was the same purchase at the same batch how it would have to vary even that much. Do you know whether those were the same purchases? A. I don't think I could tell. I could not tell.

Mr. Lyon: Can I ask if these different batches or different purchases of raw hydrochloric acid were checked against any C. P. blanks so that you could tell the difference? A. We have analyses and inhibition tests of every batch of crock acid that was used in every run that was made.

Mr. Lyon: Against C. P. acid? A. Against C. P. acid and analyses. They are not in the report.

The Court: But you have those figures? A. We have those figures, if they want them. They were substantially in every run within a few per cent of the corrosiveness of C. P. acid, the commercial acid that we obtained from Grasselli.

Mr. Owen: I would like to have the Tables II, III and IV marked as PX-177, 178 and 179 and offered under those numbers.

(Plaintiff's Exhibit Nos. 177, 178 and 179 were thereupon reserved.)

The Court: I don't believe anything has been offered.

I think I will say Exhibits 1 through 179, inclusive, have been admitted.

Mr. Owen: Before going on with the examination of the witness, if Your Honor please, I think it may be well tc identify these tables that we were going to offer; and I will state that a copy of this report was handed to defendant's counsel just before the adjournment last evening.

Now, PX-173 was a table to be supplied, and I find that on this report, pages 7, 8 and 9, are several tables which I had intended to combine as that exhibit, so I suggest that the table on page 7 be marked PX-173-A.

(The table in question was then marked PX-173-A.)

Mr. Owen: Then on page 8 there are two tables which I will have marked PX-173-B and PX-173-C; and on page 9 there is another small table which I will have marked PX-173-D.

(The tables above mentioned were then marked PX-173-B, 173-C and 173-D.)

Mr. Owen: Then, Your Honor, to identify the other exhibits in this report, the exhibits which were identified last evening, PX-174 is on page 34 of the report. That is the drawing of the apparatus.

On page 35 there is an enlarged detail of the delivery end of the apparatus, and I would like to have those both included in this exhibit, marking page 34 as PX-174-A and page 35 as PX-174-B.

(The pages above mentioned were then marked PX-174-A and 174-B.)

Mr. Owen: Then PX-175 is the photograph of the crock, which is on page 33.

(The photograph was then marked PX-175.)

Mr. Owen: PX-176 is Table I, which is on page 25.

(The table above mentioned was then marked PX-176.)

Mr. Owen: PX-177 is Table II, which is on page 26.

(The table above mentioned was then marked PX-177.)

Mr. Owen: PX-178 is the table on page 27.

(The table above mentioned was then marked PX-178.)

Mr. Owen: And PX-179 is the table on page 28.

(The table above mentioned was then marked PX-179.)

Mr. Owen: Doctor, at the adjournment last evening you had discussed your Tables Nos. I, II, III and IV. Can you state what the average loss of weight, or, in other words, the average amount of iron taken up in the acid as it passed through the pipe would be for these four runs, basing it on so many grams per hundred feet of tubing per hour of contact between the acid and the tubing? A. I have those figures here. In runs 1-A and 1-AA, taking first 1-A, the amount of iron dissolved from the tubing, expressed in grams of iron per hundred feet of length of tubing per hour of contact was 289 grams. In run 1-AA the rate of dissolving the iron per hundred feet of tubing per hour of contact was 273. So in the first set of tubing, that is, tubing in Set No. 1, why, the average was 281 grams.

And in the second series 2 tubing runs, with the commercial 15 per cent acid, run 2-A, the rate at which the iron dissolved per hundred feet length of tubing per hour of contact was 256 grams of iron. In run 2-C the rate of dissolving of the iron per hundred feet length of tubing per hour of contact was 239 grams. And the average on that tubing was 248.

Q. And have you the average for the four runs? A. You could. You could average 248 and 281. It would be 264½.

Q. Did you make runs similar to those covered by your tables Nos. I, II, III and IV, in which you made additions to the acid? A. Yes. Those results are reported in Tables V, VI, VII and VIII.

Mr. Owen: I might as well at this time mark those tables as exhibits. Table V as PX-180. Table VI will be 181; Table VII, 182, and Table VIII, 183.

(The tables V, VI, VII and VIII were thereupon marked respectively PX-180, 181, 182 and 183.)

Mr. Owen: Now will you explain in connection with your Table V what that one was, how it was conducted? A. The run 1-B which is reported, or the data reported on Table V, the commercial acid was diluted in the stoneware crock to 15 per cent concentration and metallic chlorides,

that is iron chloride, lead chloride, and copper chloride were added to correspond to the composition of defendant's acid as reported by Professor Bartell. Those amounts of metallic chloride were added to the acid. The acid was agitated and before running the acid through the tubing system, why, a chemical analysis was made upon the acid to determine the metallic concentrations, to check on the weights of chemicals that had been added.

Mr. Lyon: Did he add the total amounts that were found in the defendant's well samples or did he add the amounts that represented the difference between the defendant's well samples and the amounts that were in the raw commercial acids? A. We added the difference between the amounts found in the commercial acid and the figures as reported here. In other words, we added the amount of copper, lead and iron that would build the final concentration up to the figures we desired.

Mr. Owen: And what were the figures to which you built up the acid? A. The figures we built up the acid to correspond to the compositions that Dr. Bartell recorded as having been found in the defendant's samples.

Q. Well, for the purpose of the record, it is in the record, but to get it in connection with your testimony, please state to what copper and lead content you built up this acid before running it through the pipe. A. The contents are all reported on the sheets and therefore if I can go through those it would specifically give those concentrations and there will be no question about it.

Q. Well, now, as I understand, figures indicated on Table V at the bottom of the second column show the amount of lead and copper contained in the solution at the beginning of the run. A. That is correct.

Q. Now before we go into this, I will ask you if you analyzed these commercial acids as you received them or if you tested them for inhibition? Please state just what you did and what you found. A. The commercial acids were not analyzed as we received them. The commercial acids were analyzed after they had been diluted to 15% concen-

tration in the crock just prior to adding the chemicals to the acid. The reason for doing that, of course, was we used approximately 8 carboys of acid and we wanted to be sure that the acid that we finally had in the crock before we added the chemicals was representative of commercial hydrochloric acid diluted to 15%. Therefore, the analysis was performed at that time to insure no other impurities had gotten in in the transferring of the acid from the carboys to the crock and in the dilution of the acid. And so we analyzed the acid at the time after it had been diluted to 15% with tap water before these other chemicals were added.

Q. What amount of inhibitor, or what amount of inhibition did you find in the commercial acids as diluted to 15 per cent? A. The per cent inhibition as found in laboratory tests on this diluted 15 per cent acid ran from 0 per cent to a maximum of 6½ per cent inhibition, when compared in corrosiveness with 15 per cent C. P. hydrochloric acid.

Q. And those figures you have just given are for the solutions which you used as they existed before the runs were made, is that right? A. That is correct. Before any additions of metallic salts were made.

Q. Now, will you explain your Table V?

Mr. Lyon: Can I ask one question, Mr. Owen? The witness said that this figure at the bottom of column 2 corresponded to some figure that Dr. Bartell had given. I am unable to find in Dr. Bartell's reports where any of the samples of defendant's well acid that he analyzed, which he reports for these parts per million of lead and copper, so I am unable to understand what figure Dr. Bartell gave to the witness. A. I would like to correct the statement I made prior. Two of these runs, that is, of these runs with synthetic chemicals, were made to duplicate acid which we prepared in a Menaul tank which contained a lead sheet. We duplicated the Menaul tank system of the steel tank and lead sheet at the bottom which was being used to transport their acid, and we will report on those tests later, and

we got a certain composition of acid out of that tank, which differed somewhat from the field samples that were reported, so two of these tests are tests in which we ran the same composition of acid that we got out of that Menaul type tank, which did not differ greatly in the composition of the inhibiting metals from the field sample analyses as reported by Dr. Bartell, so two tests are run upon synthetic acid mixtures duplicating the Menaul type acid that we obtained out of the Menaul type tank, and two of them duplicate the analyses as reported to us by Dr. Bartell through Mr. Rebbeck of the Dow Company.

Mr. Owen: I think it is a matter of little importance whether these metal contents correspond exactly with Dr. Bartell's figures, or not. What these tables show is the effect of the presence of the amount of copper and lead which are specified in the tables, and whether they exactly agree with some other tests I do not think is important, so I will ask the court and the witness to consider these tables individually, and explain just how much copper and lead were in each of these runs—how much copper and lead were contained in each of these runs.

The Court: I am not to understand, as I understand it, that your Table V is exactly according to the formula of the defendant's acid, as analyzed by Dr. Prutton? A. It is not.

The Court: It is a synthetic one that you made? A. It duplicates an acid that we made in a Menaul type tank.

The Court: You analyzed it, and this is what it had in it? A. Yes.

The Court: This really is the explanation of it, you made a synthetic acid in this way, and you are going to show the results?

Mr. Owen: That is right.

The Court: That is all you claim for it? A. Yes.

The Court: All right. That is fair.

The Witness: In the first column the run number is 1-B. The acid was prepared, and contained 390 parts per million of lead, 2.79 parts per million of copper, and 1682 parts per million of iron. The figure for the iron is given

over under the fourth column, and samples were taken at the inlet, under parts per million of iron. It is the second sub-head under the fourth column. It is the average of two samples taken during the run. This acid was prepared and had those compositions, and then it was allowed to run from the crock through the tubing system that I described previously; and the samples of exit acid were taken and analyzed for iron; and the concentrations of iron in the exit samples are given in the fifth major column, the second sub-head, parts per million under samples taken at the outlet. The initial sample was 3250 parts per million.

The first composite sample was 1990 parts per million. The second composite sample, 2010 parts per million. The third composite sample, 1942 parts per million of iron. Calculating the grams of iron dissolved by the acid in passing through the pipe, there were 238 grams of iron dissolved from the piping system in the test.

The Court: That is, free iron? A. That is free iron. This is calculated as free iron. The weight of the iron dissolved from the pipe is actually that 238 grams. 238 grams is very close to a half pound. On the blanket run in this same tubing, that is the one with just the commercial acid without these added chemicals, and they are numbered 1-A and 1-AA, there were about two pounds of iron dissolved; and when we put those added chemicals in, it cuts it down to about a half a pound of iron dissolved.

Q. Will you take up your Table VI, PX-181, and explain it? A. Table VI is acid that was prepared to duplicate our synthetic Menaul acid prepared in our Menaul type tank. The run number is 2-B. The acid contained 316 parts per million of lead; 3.07 parts per million of copper and 2315 parts per million of iron at the inlet. We ran the acid through in the same manner, and the outlet samples, the samples leaving the end of the tubing system, initially showed 5970 parts per million; the first composite sample 2750 parts per million, the second composite sample 2770 parts per million and the third composite sample 2610 parts per million of iron. Calculating that into grams of iron dis-

solved from the tubing by the acid, it is 299.8 grams of iron dissolved, or again very close to a half a pound.

Q. Now, taking up your Table VII, PX-182, please explain it.

Mr. Lyon: Can I ask a question about Table VI. Is Table VI another run of this raw acid in a Menaul type tank? A. Oh, no. This was no Menaul type tank at all. It was run from a stoneware crock through tubing. That is all that was done.

The Court: That is what I thought.

Mr. Lyon: I understand your explanation to that effect, but Table No. VI is like Table No. V in that you determined the amount of copper and lead you added to the raw acid from your tests with the Menaul type tank, rather than from the directions given to you by Dr. Bartell? A. Oh, yes; that is correct.

The Court: He made this synthetically, and what he made it to was not something that Dr. Bartell had made, but something he had made by the experiment that we are going to compare, so far as it does compare, with the way the defendant treats and carries its acid. A. That is right; that is correct.

The Court: I have got the theory of your experiment.

The Witness: We wanted to find out whether that composition of acid, when separated from the lead plate and steel tank, would stop the corrosion of the tubing.

The Court: Where we got started wrong, in some way we got the idea that these had to do with the figures Dr. Bartell had given you, and you synthetically made up to what he had, and all we had to do was to disabuse our minds of that. A. In Tables VII and VIII we are going to take up that type of test.

Mr. Owen: Well, now, take up Table VII, doctor, and explain that. A. In Table VII, the composition was adjusted to the composition as reported by Dr. Bartell as existing in the average of samples he had analyzed of the defendant's acid.

Mr. Lyon: I want to just stop there. I have been

having trouble last night finding anything in Dr. Bartell's figures that corresponded to those the witness has given.

Mr. Owen: I will say it is not going to be claimed these exactly duplicate Dr. Bartell's findings. Let me explain. Mr. Rebbeck wrote to Dr. Prutton and told him what the averages of the samples taken from the defendant's wells were as to their metallic content. Dr. Prutton started from that point. Now, whether the actual amount in parts per million of copper and lead in Dr. Prutton's Tables VII and VIII correspond in the minutest detail to the number of parts per million Dr. Bartell's tests average up, I can't say, but I do say that the figures will show for themselves, if we compare Dr. Bartell's figures with these and they are a few parts over and under.

The Court: And we will be able to do that and if they are a little bit off, we will have to adjust them a little.

Mr. Owen: That is the position I take, Your Honor.

The Court: All right. Go ahead on that premise.

The Witness: Table VII, we have run 2-D. The composition of the acid was made up and the final acid before running it through the tubing contained 455 parts per million of lead, 3.7 parts per million of copper, and 418 parts per million of iron. The acid leaving the system, the initial acid out, contained 2295 parts per million of iron, 688 parts per million of iron in the first composite sample; the second composite sample, 697 parts per million of iron; and the third composite sample 669 parts per million of iron. The total amount of iron picked up by the acid was 195 grams. That figure is somewhat less than I found in the iron.

The Court: Let me see, how did you get that 195, by actual weight? A. We actually count them, the volume and acid that has gone through in between taking these samples, and the increase in iron content.

The Court: Did you compute them separately for each one of those four figures of iron? A. We computed the amount of iron. We computed them separately.

The Court: You took that first gallon that went through and computed at that high rate? A. Computed

each one of them separately, and then we computed the other quantities of iron at the total volume of inlet acid, and the difference between the sum of these exit acid composites and of the inlet acid, that difference was the amount of iron dissolved.

The Court: Here is what I was getting at, not whether there was anything wrong about your averages. As I understand it, you didn't take an average of four at all, but you took the first run there, and what did that figure, 2995? A. Yes.

The Court: You took all included within the next three sample all at this average figure of 688? A. That is the figure of 62.7 gallons of acid which had run through at that time.

The Court: Then you computed all that ran through during the next three periods at 697? A. That is correct.

The Court: All at the other three periods at 667. A. That is right, and added them together.

Mr. Owen: Would Your Honor like to know how he converted these parts per million into grams?

The Court: Yes, I would.

Q. Will you explain that? A. We have a sample calculation. This is for run 1-A. It is in the report, on page 16, and at the time of taking the first composite sample the gallons of acid that had gone through the tube was 76½ gallons. And went from zero to 76½, and in the acid there was one hundredth of a milligram of iron per cubic centimeter of acid.

The Court: Yes. A. That is we recorded our analyses that way, not quite parts per million. It is a different method of recording. One hundredth of a milligram per cubic centimeter of acid, and that was the inlet acid. The exit acid contained 1.22 milligrams of iron per cubic centimeter, and therefore the difference came in with .01 and came out with 1.22, which was 1.21 milligrams of iron per cubic centimeter.

Now, if we take the total number of cubic centimeters that have gone through 76½ gallons, a gallon is 3785 cubic

centimeters, and 85 cubic centimeters, one gallon is 3785 centimeters, so we multiply the gallons times 3785 and we get the total number of cubic centimeters that have gone through during the time of taking the composite sample that we have reported here. That is the total number of cubic centimeters. Now, each cubic centimeter picked up 1.21 milligrams of iron, and therefore we multiply that by 1.21 and we get the total number of milligrams of iron dissolved by that 76½ gallons of acid running through, and then you divide by 1000 and we have the number of grams of iron picked up for that first slug of acid, 76½ gallons dissolved 350 grams of iron.

The Court: Then you did the same thing on the others and added them together? A. Yes, that is right.

Mr. Lyon: I am still somewhat in the dark on one question, to which I would like an answer. I am just trying to get an explanation of this, that is, the final amount of lead and copper as reported at the bottom of column 2, Tables VII and VIII, is quite different. If those are both based on something from Dr. Bartell, I would like to know what accounts for the difference.

The Court: To date, we are forgetting that it is from Dr. Bartell at all, as I understand. A. I would like to explain that difference. In preparing these acids and dissolving the chlorides in the acid, it was very easy to get the iron chloride in the solution, and we could get whatever we wanted in the iron chloride concentration. To dissolve the copper chloride and get an exact copper concentration was also very easy; and, as has been reported by myself and Dr. Bartell, the copper is the vital element in the inhibition. The lead contributes some inhibition, but it is not nearly as vital as the copper concentration.

The Court: But it needs the copper to do its own work, does it not? The lead needs the copper to be effective, does it not? A. The two cooperate, but just the extent of the cooperation is difficult to tell from any tests that have been made; but they seem to cooperate, both contribute an inhibiting effect, but the copper seems to be the

one that does the major part of the inhibiting. If we take the final mixture, if we drop out the lead and iron, the copper would almost do what all three do. In dissolving the lead chloride in the acid, it is not very soluble—the concentration that we do get is almost a saturated solution, and, therefore, it was very difficult to dissolve lead chloride and get exactly what we wanted in the final acid, due to that slow rate of solution. And we did not feel that if we missed the lead concentration by 50 or even 100 parts per million that it made a great deal of difference, because the lead, although it has an inhibiting effect, our laboratory tests had shown that going from 250 parts per million to 500 parts per million of lead did not change the amount of inhibition to any extent. Oh, maybe 1 per cent. And therefore, if we hit fairly close on the lead, if we got the copper exact, and hit fairly close to the lead, as close as we could due to the difficulty of getting it in solution, and the iron is immaterial, but we could hit that whatever we wanted to, because it dissolved readily, and the lead is the one we couldn't get exactly what we wanted, due to this difficulty in soluble effect, and therefore the lead will differ. And so the figure that was given to us as the composition of—through Mr. Rebbeck, the average composition of defendant's acid as found by Dr. Bartell, as I stated, as he stated in his letter, 3.8 parts per million of copper. Well, on run 2-E, which is in Table VIII, the acid was exactly 3.8 parts per million of copper. In run 2-D the acid was 3.71 parts per million of copper which was substantially identical. The lead, however, in run 2-D was 455 parts per million, whereas in the analyses it was lower than that. I don't recall the exact figure. The amount that we had in run 2-E was 340 parts per million of lead. But our laboratory tests and the tests of others indicated the lead to be varied from 250 parts per million to 500 parts per million and the corrosiveness or inhibition of the acid was substantially identical.

The Court: Now is that true without the presence of copper, or in any acid with the presence of copper? A. It is substantially true whether there is copper present or not.

Mr. Lyon: Your Honor please, I would like to call your attention, while you are considering that, to one thing. The witness, as I understood his explanation to you, said the significant thing was the amount of copper. And you could disregard the lead.

Mr. Owen: No, no.

Mr. Lyon: Well, not disregard it, but—

The Court: But small differences.

Mr. Lyon: Yes. Well, now, I call your attention to Tables VII and VIII. They have apparently almost the same identical amount of copper, and yet the rate of corrosion in Table VII seems to be almost twice that of Table VIII, so there is something wrong here.

The Court: He hasn't got to explaining that. I could draw, probably, the same conclusion you have, to just look at it, but I am not going to until I hear what he says about it.

Mr. Owen: If I can get along, first I want to explain this matter of Dr. Bartell's sample that has been questioned, and if Your Honor will turn to your Exhibit PX-169 and go over to the right hand portion, under the heading "Truck Acids," it gives in that, under the heading, first the Stella Wilcox, then the Zahn and down below, in the separate column, the Crawford, and over to the left of the exhibit, the first line is copper. The first figure of 15 grams, or 3.6 parts per million, shows how much copper there was in that Stella Wilcox sample. And then to the right of that, under Zahn, 13 grams or 3.1 parts per million, was how much copper there was in the Zahn sample. Then if you drop down under Crawford in the first column it shows 20 grams or 4.8 parts per million. The average of all three copper contents is 3.8 parts per million. The amount of copper in Dr. Prutton's Table No. VII is 3.7 parts per million, and that in his Table No. VIII is 3.8 parts per million, so that is about as close as anyone could be expected to get.

Now under the lead content, the second line of figures, under truck acids, is the Stella Wilcox, lead 1700 grams or

417 parts per million; under Zahn 1800 grams or 435 parts per million; and under Crawford is 220 grams or 53 parts per million, and the average of those is 301 parts per million. Dr. Prutton's Table VII has 455 parts per million of lead and his Table VIII has 340 parts per million of lead.

Now, if you look at the next line below it shows the iron content, and under Stella Wilcox it was 1900 grams or 473 parts per million; and in the Zahn 1500 grams or 380 parts per million of iron, and under Crawford it was 860 grams or 210 parts per million. The average of those was 354 parts per million. And in Dr. Prutton's Table VII he had 418 parts per million of iron, and in Table VIII he had 382 parts per million of iron.

Exhibit PX-160 is Bartell's own averages of these samples. Your Honor will see they are very close to Dr. Prutton's.

Mr. Owen: Now, Doctor, will you go on with your explanation of Table VIII? A. Table VIII, Run 2-E is reported. The lead content of the acid 340 parts per million, the copper content 3.8 parts per million, the iron content 382 parts per million. The exit acid leaving tubing system, the first composite sample, 550 parts per million. We didn't take the initial out. That amount was of such a small volume, although it may be high, is negligible in comparison with the total and the first acid sample includes that.

The Court: If you made that very small and part of it got over into this No. 1, that, of course, would bring that 550 a little higher? A. A little higher, yes. One gallon out of 191 gallons, no matter how high it is, practically makes no difference. The second composite sample, 508 parts per million of iron; the third 483 parts per million of iron; the total amount of iron picked up by the acid was 101.4 grams.

The question was raised as to why this figure was 100 grams and the other was 195 grams. The statement is made that the acids should give substantially the same amount of inhibition. When you have an inhibited acid and you compare the difference between percent of inhibition and 100 percentage, you get into small differences and you can

magnify interpretations to get a very erroneous picture. The picture that these tests present to me is, first, that we ran commercial 15% hydrochloric acid through the tubing and got a loss of about 2 pounds of iron; secondly, we ran commercial acid to which we added the metal contents, varied somewhat, we got from one-quarter to a half pound of iron—approximately that range. It is impossible to exactly duplicate the preparation of the surfaces of the tubing in each run, and therefore I do not believe that the figures given in this report are any more accurate than plus or minus 75 grams, or some figure like that.

In other words, that there is a variation between the preparation of the surfaces that has to be considered and therefore you should look at the thing in a broad way in taking into account the accuracy of the method and the variations that might occur in the preparation of the inside surface of 20 foot lengths of tubing. I really was surprised at the accuracy we really got in comparing these tests.

The Court: This is about a sixth of a pound? A. No, about a quarter of a pound. And the other sample of 195 is about .4 pounds, the other close to .5. So it is between ¼ and ½. All of these synthetic acids run in that range. So comparing these two—

The Court: From the corrosive standpoint— A. As I say, I don't believe that these results are more accurate than plus or minus 75 grams as the outer limit of accuracy and that here we got 195 and 101 grams as the amount of iron dissolved.

The Court: You dissolved much less iron. About half as much? A. That is correct.

The Court: So if it will do the other work it would be much more desirable? A. Yes.

Mr. Lyon: May I ask what that means, Your Honor? He says that his results might be off or not accurate by 75 grams. That would mean in the case of Table No. VIII that the results are inaccurate to what per cent? I mean what per cent could you say the test was accurate? A. No, I would say that the test—I have not tried to compute any

per cent accuracy because I don't think it is possible, but the interpretation of the tests you have to include a consideration of the variables that are involved in the test, and I would say that this particular test, the actual amount of iron dissolved I am sure is 100 grams or very close to that at least. It might be somewhat more. We did not include the initial sample, due to some error. That would have stepped up a little bit the iron and it might be 150, or something like that. Actually in the weight loss of the tubing it was closer to 200. We weighed the tubing, and in this check we got this 101 grams dissolved in solution by our analysis, but when we weighed the tubing the loss in weight of the tubing was closer to 200 grams, so I would say it was somewhere from 100 to 200 grams of iron dissolved. The average would be about 150.

The Court: It is sort of an experiment if you wanted to check yourself by running two experiments you would have to rig up the thing the second time? A. Yes.

The Court: You couldn't keep using that over and over, the same tubing? A. We used the tubing over and we have data to show that. We have run a series of laboratory tests with this 1¼ inch tubing, running one run with an acid and getting the inhibition or corrosiveness of the acid, then taking it and putting it through this cleaning and brushing operation and running it over again, and we can check with that reuse of the tubing, we can check within about 10 per cent, within about 10 per cent.

The Court: Do I understand you have performed experiments that would be duplicates of this here? What I had in mind was as to your frank statement as to accuracy. I was wondering if I was to understand from that that it is your opinion that if you tried to run the very same experiment there during several times there would be— A. Differences.

The Court: A difference. Then it gets down to about what per cent? A. Oh, it is about 10 per cent.

The Court: Isn't that what you were asking?

Mr. Lyon: Yes. Although of course an error of 75

grams in the case of Table No. VIII would be bigger than a 10 per cent error. A. That isn't the statement, or else I made it wrong. I don't believe that 100 grams could be 25 per cent, I don't think that. It was actually 101 grams increase in iron as determined by analysis. That is fixed. But there might be more dissolved than that, somewhat more, and it might be 75 grams more. That is about what I meant.

Mr. Lyon: You made that statement which puzzled me last night, that you find more loss of iron on weighing the pipe than you can find present in the acid in all these tests? A. I will tell you why that is true, because before re-weighing the pipe when we clean it out the inside surface will rust slightly, and very rapidly after washing with water, and we ran that reamer in and dried it again and it took out a little loose iron, and we got more iron out, so the weight loss, we do not rely on that.

We can absolutely rely on these chemical analyses as being within 10 per cent of the figures, and we are talking here about 70 and 80 per cent reduction of corrosiveness, and 10 per cent on that is not a major factor, in a practical sense. If we were down talking of 10 per cent inhibition, 10 per cent would be a major factor. We are talking about 60 and 80 per cent.

Mr. Owen: In your Table VII, the total grams increase in iron which you gave at 195 includes the iron that came out in the initial out gallon of acid, and in the Table VIII the figure of 101.4 grams does not include that, is that correct? A. I would have to check on that. I believe that is the way it was done. As I said before, the concentration in the initial out, since it is only one gallon of acid, is a negligible amount, as a rule, and I wouldn't want to rely on that difference in the report here to indicate that that was the cause of the difference. It might account for a few grams, but it wouldn't be a major thing.

Q. Now, I wish you would in connection with Tables V, VI, VII and VIII do what you did in connection with Tables I, II, III and IV, that is, compute the loss, the

average loss of weight per 100 feet per hour of contact between the acid and the walls of the pipe? A. In Table V, run 1-B, the tubing lost 64.4 grams of iron per 100 foot of length per hour of contact. In run 2-B, the tubing lost 84.6 grams of iron per 100 foot length of tubing per hour, and the average of those two, 84.6 and 64.4 would be 149 over 2, which would be 74.5. Then in run 2-D the loss in weight was 59.3 grams of iron per 100 foot length of tubing per hour, and in run 2-E it was 29.4 grams of iron, and the average of those is 44.4. The average of the averages is 59.4.

Q. And the average of the average in connection with the first four runs is 264¼? A. Yes.

Q. Now, can you explain in some way the relative rates of corrosiveness indicated by those two sets of runs, the first four being without an addition of copper or lead, and the second four being with additions of those metals? A. Well, if you take—

Mr. Lyon: I am going to object to that on the ground it includes the result of Table No. VIII, which is admittedly way out of line, because there was no initial sample taken, and the result almost 100 per cent below No. VII, which had the initial sample, and on the witness' statement, as it contains the same amount of copper, that it should have the same value, so where we are averaging figures in here that are admittedly wrong it should be excluded.

Mr. Owen: I object to the statement that the figures in Table VIII are admittedly wrong. The witness has explained that the figures in any one of these tables are not stated to be accurate to the last degree, and they were all made in the same way, the tests were made in the same way, and the analyses were made in the same way, as I understand it. A. That is correct.

The Court: Well, I will let it go in with your criticism of it. You may put that in.

A. Well, if we take the corrosiveness of the first four runs of commercial 15 per cent acid as 264¼ and the average of the last four runs with the added metals as 59.4,

why the commercial acid is 264 divided by 59, or the commercial acid is 4.46 times as corrosive as the synthetic acid. The average of these four—

The Court: Do I understand from the eight, however, there is omitted from that all that ran through in the first twenty minutes? A. That is not omitted.

The Court: You took these samples every twenty minutes? A. Yes, but the initial sample was taken in the first gallon that came through. The first single gallon that came through, and then the average sample was taken over that twenty minute period, and including even that first gallon.

The Court: One gallon? A. Yes. It is a very small amount and it has very little significance.

The Court: While it is high, in a gallon there couldn't be very much? A. Out of 180 gallons that we ran through.

Mr. Owen: Doctor, how much difference would there be in the figure you have given in your last answer if you omitted Table VIII entirely and took the average of Tables V, VI, and VII for the runs in which you added lead and copper?

Mr. Lyon: My point is, Your Honor, these averages seem to me have to be scrutinized very carefully, because when you average two tests that are almost 100 per cent apart, why you are taking quite a liberty with an average.

The Court: I recognize that.

A. If you take the average of the first three tests, omitting the test described in Table VIII, the average amount of iron dissolved was 69.1 grams per 100 foot length of tubing per hour of contact. That is compared with 59.4 grams loss if you take all four and average them, and the raw acid, or the 15 per cent acid, the number of times more corrosive than that is in the acid of the first three would be 264¼ divided by 69.1, which is 3.83, so it is 3.83 times as corrosive, so taking either the first three, or the four, and averaging them up, the corrosiveness of the raw 15 per cent acid is about four times as great as that of these acids to which the metals have been added.

Q. What was the size of your tubing you used in these

tests? A. The tubing that was used was standard inch and a quarter oil well tubing.

Mr. Lyon: May I ask you how much it weighed per foot? A. I think that is in the report. It is right on the first page of the report. Page 3, the first one and a quarter inch oil well tubing, external upset, range 1, 2.41 pounds per foot of length.

The Court: I don't know if I got an answer to my question. This bears the date June 20, 1941. Were all of these things done prior to that? A. Yes.

The Court: They were all done before that, and then you made up the report? A. Yes.

The Court: And shortly before? A. Yes.

The Court: I don't care about, as far as I am concerned, the exact date, but this date here is after you got through all of this. A. That is correct.

The Court: You tabulated this. A. Yes.

The Court: All right.

Mr. Owen: Now, I would like to offer the report as PX-184. The offer includes all of the other PX's which have been identified in the report.

The Court: Well, I will admit that. The entire report of June 20, 1941.

(Dr. Prutton's report of June 20, 1941, was thereupon marked PX-184.)

Mr. Owen: Doctor, what is the size of the tubing used in oil wells generally? A. Usually it is about two inches.

Q. Can you compute what the loss of iron would be in 1,000 feet of 2 inch oil well tubing, taking as the rate of loss the average of your first four tables, I, II, III and IV, which you gave as 264¼ grams from 100 feet of 1¼ inch tubing with contact between the acid and the tubing for one hour?

The Court: Just on the inside.

Mr. Owen: Just on the inside. A. Just on the inside. The inside area of 2 inch tubing for 1,000 feet is about 540 square feet. The inside area of inch and a quarter tubing, 1,000 feet long, is about 340 square feet. So if we multiply

264¼ by 10 we get the amount of iron that would be dissolved from 1,000 feet of inch and a quarter tubing in one hour, and then if we multiply that by the ratio of the area, inside area of the 2 inch tubing to the inside area of the 1¼ inch tubing, we would get the amount of iron that would be dissolved from 1,000 feet of 2 inch tubing, and if we do that the figure comes out to be about 4200 grams. 4200 grams of iron would be dissolved in one hour from 1,000 feet, the inside of 1,000 feet of 2 inch tubing.

Q. And that is about 9.3 pounds of iron would be dissolved in one hour, 4200 grams.

Mr. Lyon: Do you have what per cent of the weight of tubing that is? A. No, I do not.

Mr. Owen: Now, in what form would that iron go down into the well? A. Well, it goes down as a mixture of ferric chloride and ferrous chloride.

Q. What action would those ferric and ferrous chlorides have in the well if they got into the formation?

Mr. Lyon: Well, I object to that on the grounds there is no foundation laid. I mean he is not entitled to express an opinion unless he is qualified. He hasn't testified to any knowledge of oil well formations or any experience with them, or anything of the kind.

The Court: I will overrule the objection. A. A solution of acid containing an appreciable amount of ferrous chloride or ferric chloride contacting calcium carbonate, which is the main ingredient of limestone, the ferric chloride would precipitate as ferric hydroxide and there would be a tendency to plug up the pores of the formation due to that precipitation. The ferrous chloride would have some effect upon the viscosity of the solution, making it a little thicker if it were present, thus retarding its entrance into the formation. In forming the ferrous chloride some of the acid has been consumed, and therefore the acid concentration would not be as great as it should have been. That is, as great as 15%, which is the concentration usually forced into the top of the well.

Mr. Lyon: I don't understand that. How much did

you say the concentration was reduced in this particular instance that you are testifying to? From 15% to what? A. It would be reduced—I haven't figured that out. I can figure it out.

Mr. Lyon: I would like to know what you are testifying to. I would like to know whether that is a significant quantity or not. In this example you have given, how far would the concentration be reduced? From 15% to what? A. Well, this calculation wasn't made for the intent of showing any exact reduction, but if we take a typical oil well, which is usually a couple of thousand feet deep, and give some contacts of the acid of 15 hours instead of one hour—

Mr. Lyon (interposing): No, take two hours. A. Well, multiply 3 times 15, and we get 45 times as much corrosion.

Mr. Wiles: This is not cross examination.

The Court: This is so complicated, maybe you better wait. I am glad to have it, but I think there is some other little thing that is involved that you can bring up in cross examination.

Mr. Owen: Doctor, you have referred to tests you made in a tank, or placing acid in a tank which you have referred to as duplicating the Menaul tank. Will you explain what tests you made, how you proceeded. And in that connection, I believe you have a report. A. Yes, I have a report of the tests.

Mr. Owen: I will hand up a copy of this report to the court so the testimony will be followed and will give a copy to defendant counsel (handing same to court and counsel).

Q. I think first, Doctor, I will ask you to explain the construction of the tank which you made. A. We prepared a tank, a steel tank of 240 gallons capacity, duplicating as close as we could the important details of the construction of the Halliburton truck tanks from the information received from Mr. Rebbeck of The Dow Chemical Company. He supplied us with a drawing of the tank, a statement as to the material the tank was made of, a statement as to the

relative area of lead sheet in the bottom of the tank to the area of the inner surface of the truck tank, and as to the composition of the sheet lead used, as well as the methods of assembling the sheet lead into the steel tank. From those instructions we prepared a steel tank which is described in this report. The tank was 34 inches square by 50 inches tall.

Mr. Owen: May I interrupt just a minute. I think, Your Honor, I will have this report identified as PX-185, and then we can refer to pages.

The Court: We will call this whole report PX-185.

Q. Now, what page are you referring to? A. Page 3 is a description of the tank that we prepared.

Q. And where is that tank illustrated in the report? A. On page 14 there is a side view of the tank in position for the runs, page 14, or Figure 2.

Q. Page 14 is a photograph in my copy. A. That is a photograph of the tank. Figure 3 on page 15 shows a sketch of the tank and shows some of the details of fastening in of the lead sheet on the bottom.

Q. You might explain that. A. That figure 3 should be viewed in the other direction. If you hold the report on the side, the bottom of the tank is down here (indicating) and this upper edge with reinforcing rim is on the top. The tank was prepared from manufacturer's Grade A steel plate ¼" thick and was fabricated for us by the J. T. Ryerson Company of Cleveland, Ohio. The tank was electro-welded. The inside of the tank was cleaned by sand blasting. And then a sheet of chemical grade lead was fastened inside the tank on the bottom. The sheet of lead was burned into a strip of steel, as described on page 3, on opposite sides of the lead sheet which was 33 inches square and ⅛ inch thick, two strips of No. 10 blue annealed steel, three inches by 33 inches, were fastened to the edge of the lead sheet by burning.

The Court: What was fastened to the lead sheet? A. Two strips of No. 2 blue annealed steel. Just thin sheet steel.

Mr. Owen: Does that appear in that Figure 3? A. That is the heavy horizontal line.

Q. The steel is in an "L" shape, is it? A. The steel, as I recall, was in a flat sheet, and this figure isn't quite correct as I recall. I can find out in just a moment, if I could ask my assistant.

A Voice: It was "L" shaped. A. It was an "L" shaped piece. It was not just a flat strip. That is right.

The Court: The sheet right at the corner? A. The sheet right at the corner.

The Court: Extending up along the side and a little ways out on the bottom. A. The lead sheet was burned to the bottom part of that "L" and then the "L" of this blue annealed steel strip was welded onto the side of the tank at three points, in order to tack it onto the side of the tank. So the upper half of this strip at three points across there, the strip was welded onto the steel tank.

The Court: Does the lead extend up along the side at all? A. No.

The Court: The lead is just on the bottom? A. On the bottom, yes, and this "L" shaped strip of steel was burned to the lead, and it was spot welded onto the side of the tank in three places. Now, the tank, before use in these tests, was polarized, or that is the term used by the Halliburton Company for this operation. As stated in letters from Mr. Rebbeck, the Halliburton Company polarizes their truck tanks. They prepare the tanks.

Mr. Owen: Your Honor will recall, that was in Mr. Edwards deposition, which was read into the record.

The Court: Yes, I remember. A. They prepare the tanks when they are new with the steel and lead sheet assembly, and then they fill the tank with acid, and into the tank, the top of the tank, they insert a strip of sheet lead, and they connect that sheet lead with the positive pole of a lead storage battery, and they connect the tank with the negative pole of that storage battery, and they electrolyze the contents of the tank, and with the idea that after allowing the storage battery to become discharged by

standing all night and current passing through the acid in the tank, that the tank is polarized.

The Court: Polarizing, you mean a positive and negative, is that what you mean? A. Polarizing is a term that has a very vague meaning. That involves mostly any kind of effect that reduces the voltage of an electro-chemical cell. In other words, if you have a battery and something happens to it and your voltage goes down, then they say it is polarized, or if you are electro-plating and putting a voltage into the cell and the voltage goes out, they say it is polarized. In other words, it is a general term that indicates something has happened to disturb the voltage relationships in a cell. It is a vague term and covers many types of things. For example—

The Court: The north and south pole are the positive and negative, and the electricity does some vague and indefinite thing, that is what you are referring to by polarizing? A. Yes. It refers to that, but it primarily refers to the voltage of the cell. That is the more scientific definition.

The Court: It loses it all if it gets it? A. If it is a battery that is giving out energy, like a storage battery that you have in your automobile, anything that reduces your voltage is called polarization, because it is reducing the effectiveness of the battery, but if you have an electro-plating operation, that cell is absorbing energy from the generator. If something happens that increases your voltage, its efficiency is lowered, then they call that polarization. It is a very vague term and its use in this particular case is simply another name for lead plating the inside of a tank. That is all it is. It is just used in a loose sense. What happens is that the lead dissolves from the strip of lead which is put in the tank and plates out and covers the steel up more or less perfectly.

The Court: But you have got a steel plate in there that is the other pole? A. That is the other pole, and then the dissolving—

The Court: You don't rely on just the steel of the tank? A. No.

The Court: But when they say they polarize— A. They have the two poles, the lead strip and the iron tank, and the lead dissolves from this strip and plates out on the tank and coats over the steel.

The Court: Is that a strip of lead? A. This is a strip of iron that we fasten the lead sheet into the tank. This is the side of the tank. This lead sheet is down at the bottom. The strip comes up like this and it is fastened to the bottom, the lead sheet is in the bottom.

The Court: It doesn't cover the whole bottom? A. It covers the whole bottom.

The Court: The whole bottom is covered? A. Practically the whole bottom. When they prepare these tanks they have the lead sheet in the bottom. That will save it all the time, but they fill the tank up with acid and then they put another lead sheet in the center of this acid.

The Court: Down into it? A. Down into the center. Figure 4 shows this polarizing assembly. They put a lead sheet in there. They fill the tank with acid and put a lead sheet into it and then connect the lead sheet, this added lead sheet. That is taken and connected to the positive pole of a storage battery, but not while it is in use.

The Court: You say not while it is in use? It is while it is doing this polarizing? A. That is only done once. That is only done when they first put the tank in service, as I understand it.

Mr. Lyon: The tank is only polarized once?

The Court: Everywhere there is steel there is a tendency to do that. A. They plate lead on to it.

Mr. Lyon: In other words, you don't have to use your acid going into the well to accomplish that result. They do it in the beginning.

The Court: I guess it is a part of the building of the tank, if you want to think of it in that way.

Mr. Lyon: That is right. They lead plate the tank in the factory, or before they put it in service, otherwise they would have to be using the well operations in lead plating the tanks.

The Court: All right. But this is once in a lifetime? A. Just in the beginning.

The Court: What it does is to put a lead coating on there? A. Partially.

The Court: And we can think of that as being done and that acid taken out? A. That acid is taken out and then the tank is ready for use.

The Court: All right.

Mr. Owen: Then this lead sheet which is suspended in the tank in Figure 4 is also removed? A. That lead sheet is removed and the lead sheet in the bottom stays in there.

The Court: That lead sheet is all over the bottom, as I understand it? A. Yes.

The Court: Will you agree to that?

Mr. Lyon: I think so, yes.

The Witness: The tank was 34 by 34 and the sheet was 33 by 33, so it substantially covers the whole bottom.

The Court: That explains where I got the idea it did not cover the whole bottom, but it pretty nearly does. You cover the whole bottom? A. 33 by 33 we used.

The Court: You followed the same proportion? A. Yes.

Mr. Lyon: I understand there is a man here that operates these tanks and he says these sheets do not cover the entire bottom, but they very nearly do.

The Court: That is what he did.

Mr. Lyon: There is a certain ratio of the area of the surface of the lead to the surface of the tank, which we will have to give you the formula for. A. We had to use that same ratio as close as could be calculated from the drawings of their tank.

The Court: Now, I haven't yet got—I understand the tank is a steel tank? A. Yes.

The Court: Now, you add the piece of steel, but I haven't got that through my head yet.

Mr. Owen: The only purpose of that is to hold the lead in place.

The Court: That is the only purpose? A. Yes.

Mr. Owen: It holds the lead in place and makes contact between the lead and the iron of the tank, electrical contact.

Mr. Wiles: That was explained in one of the depositions. They said it was too difficult to solder the lead inside the tank.

The Court: As to this plating operation, if they could have held it without anything it would have been plated just the same? A. Oh, yes.

The Court: It has no purpose, only as a holder? A. That is right.

The Court: And in making the holder they make it of steel? A. Yes.

Mr. Wiles: The lead could be just as well soldered or burned into the tank direct, only some man would have gotten inside, and it was a hard job to do it.

The Court: Well, all right. Now, I have got my tank straight.

Mr. Owen: And the sheet of steel at the bottom of the tank stayed there permanently? A. Well, the strips holding the lead stay there permanently.

Q. I mean the sheet of lead stayed there permanently in the bottom of the tank? A. Yes.

Q. And the suspended sheet of lead used during the polarization is removed after that operation? A. Is never used again.

The Court: Will you give me some idea how thick a coating that is, what that means, a little bit more, on that tank, that lead plating? A. It isn't very thick.

The Court: It is nothing I can see if I look at it? A. I think you could. If you wiped it, it would probably come off, partially.

The Court: Lead is soft so it will come off. A. It will not be any major thickness, I don't believe.

The Court: A thousandth of an inch? A. Might be a few thousandths. It isn't a continuous coating. Part of the lead plating never continuously plates over the steel, so there are little holes through it that the steel is somewhat

exposed, but there will be just some particles of lead covering most of the surface. The exact thickness of that would be difficult to say, but it is probably a few thousandths of an inch.

The Court: Maybe I am anticipating again, but are you going to account for anything that happens by this lead coat that is on there to start in with, is that going to enter into our problem? A. Not as a major factor.

The Court: All right. There is an awful lot of surface of that, if we are looking for a lead surface. A. That is correct.

Mr. Lyon: That enters into the protection of the tank, doesn't it? A. The protection of the tank.

The Court: But I am wondering if now, in this, they are going to now talk to me about and have been talking to me about the inhibition that comes from copper and lead, and I am wondering whether you are going to explain in any degree or take into account in any way that lead that is already plated onto the walls of this tank in connection with that other subject I have got to think about, which is the big subject, on infringement.

Mr. Lyon: The plaintiff here is talking about the action on the pipe down the well. The primary purpose or the real purpose of our lead, bonded lead in the tank, and the action in the tank, is to protect the tank. That is the real purpose of the Menaul system, is to protect the tank.

The Court: Yes.

Mr. Lyon: What it does down to the pipe is another thing.

The Court: What they claim is that your system puts inhibition into the solution.

Mr. Lyon: They say we get some copper in and that copper really protects—

The Court (interposing): And lead.

Mr. Lyon: But they say it is really the copper that does the protecting.

The Court: Yes.

Mr. Lyon: Down the well.

The Court: They give some credit to the lead.

Mr. Lyon: Yes. But as I understand the witness the lead is a minor factor. A. Well, it may be one-fifth, if there is copper or something like that.

The Court: Let's find out right now, before we get into this, whether there is any claim that this lead that is plated onto the walls of the transportation tank enters in in any way, that plated lead enters in in any way into the claim of inhibiting the acid.

Mr. Owen: Well, I think it does, Your Honor.

The Court: Well, all right then. That is what I want to know.

Mr. Owen: My understanding is that the acid placed in that tank after it has been polarized not only dissolves lead from the lead plates in the bottom but it also dissolves lead from the walls of the tank.

The Court: I want to know what to watch for.

Mr. Owen: And that both of those are sources for the lead which is found in the treating acid. That is your understanding, Dr. Prutton? A. I think some of it comes from the sides. It is so indefinite as to the amount I can't tell how much of it comes from the sides.

Mr. Lyon: I would like to state our position so the court may have it in mind. The purpose of our system is to protect the tank. They polarize the tank to get this lead plating on it to start with. But if they didn't have this lead in the tank bonded to the steel, that lead on the walls would come right off in a short time. And, therefore, they have to have this other lead plate in there, which continues to keep it.

The Court: As I understand it, wouldn't it continue it? A. Very slightly. It would continue to some extent.

The Court: And keep it from coming off, against the taking of it off?

Mr. Lyon: We will show Your Honor how long the steel tank would last even if we polarized it if we didn't have that lead plate bonded in there to keep up the polarizing action.

The Court: I guess I have it all in mind.

Mr. Owen: I would just like to read from the opening statement of counsel, which seems to me is not entirely consistent with what he has just stated that the only purpose of this lead plate so far is to protect the tank.

Mr. Lyon: I didn't say that.

Mr. Owen: This is what he said in the opening statement: "Now, as to our method of protecting our pipe, we don't add any chemical, don't add any arsenate, don't add any chemical at all. We have an electrical method of protecting the pipes. Certainly that raises an entirely different question of infringement than anything they had in the Williams case where the defendant was adding one of the very materials mentioned in plaintiff's patent. Here we have an electrical method and it is covered by our own patent."

Mr. Lyon: Now read the rest of it.

The Court: I don't understand the change from that.

Mr. Owen: That is the end of it.

Mr. Lyon: Oh, no, it isn't. I explained to the court that theoretically the electric current, on a theoretical basis, may aid in the protection of the pipe down in the well, but that that was theoretical and could not be demonstrated.

The Court: You continue the battery during the transportation?

Mr. Lyon: That is correct.

The Court: I don't see why the same operation, leaving the tank, wouldn't tend to continue to do it.

Mr. Wiles: Did you say he continued at all times the battery?

Mr. Lyon: We have the lead bonded to the tank and keep the battery action going while the acid is being shipped out to the well.

The Court: But you don't have an outside battery?

Mr. Lyon: Don't have any battery.

The Court: Pumping on it like you did when you plated?

Mr. Lyon: That is right.

The Court: All right.

Mr. Owen: We will go into that question further later in the case, Your Honor.

Mr. Owen: Now, doctor, will you state how you proceeded when you made a run through your pipe system utilizing this polarized tank? A. The set-up of the system that we used in these tests is shown on page 17 in this report, in Figure 5. We mounted the stoneware crock, which I have described before in the former tests, on the balcony of the large laboratory, and from the bottom of that crock we have Pyrex tubing that would lead the blended acids in the crock, and we had them at the correct composition, would lead them into this Menaul tank. You might conceive that this stoneware crock is something like a storage tank in the actual field operation of this Menaul process, that the acid is diluted and then dumped into the truck tank which corresponds to this steel tank of ours.

The Court: Now, your theory was you are getting acid in this stone crock as near as you could, as you understood it, like the acid when it was dumped into the transportation tank?

Mr. Owen: Yes, like the acid after it was placed in the transportation tank, and diluted to 15 per cent. We placed in this stoneware tank a 15 per cent solution of hydrochloric acid.

The Court: I had forgotten the water. So far as anything else that is in the acid other than the water to dilute, there was nothing else placed in it? A. Nothing else added, it was simply 15 per cent.

The Court: It was like it was and in other words commercial acid, as they say at that time? A. Yes, that is all. We added nothing in the tank except water to the commercial acid. The general method of the test was to dilute the commercial acid to 15 per cent concentration with tap water in the stoneware crock. Then after analysis and making certain that that acid was satisfactory to employ in the test by running the hydrochloric acid concentration and the corrosiveness of the acid as compared with C. P.

acid, that acid was then run into this Menaul type steel tank which had previously been polarized and washed out after polarizing.

The Court: That has got the lead in the bottom and it has got the plating lead plated as near as you can do it like the defendant's tank, transportation tank is lead plated when they get it in?

Mr. Owen: Yes, Your Honor.

The Court: The only difference in the whole thing is that they have their water in this tank and then let that run in, and you put the water in above?

Mr. Owen: That is right.

The Court: So instead of my saying when you dumped it in I will say right after you dumped it in you got just what you understand they have right after they put their acid in? A. That is correct.

The Court: Both as to tank and what is in the tank. I am ready to go. A. The acid was stored in this tank before it was dumped into the steel tank, and it was adjusted to 85 degrees Fahrenheit, and was kept at that temperature in the steel tank as well, so we are running at 85 degrees Fahrenheit, just as we did in the former runs.

The Court: Well, now, that is a little bit hotter than theirs will be, unless it was last week. Last week that would be a little bit too cold for them, probably. I am just thinking. I am trying to compare everything as I go along. They probably didn't have theirs 85, did they?

Mr. Conner: If Your Honor wants to compare those particular temperatures that Dr. Prutton is running, against the actual weather temperature in this state and in the county of Ogemaw for the days on which those wells were treated, if you say so I will get those for you next week.

The Court: That was the reason they took it?

Mr. Conner: I don't say that, but I merely state I have the weather reports for those days on which these wells were treated, August 2nd and 5th, which were very hot days, as I recall it, it was up in the 80's and 90's, and

September 10th was a very hot day and it was up in the 80's all of 1938.

Mr. Lyon: It is not a question of what the temperature is in the air.

The Court: This is hotter for some reason or other than I would expect to find if I put a thermometer into one of the tanks. A. Down in the well it gets hotter.

Mr. Owen: You take a steel tank and run it several hours in the country with the sun shining, it is much hotter than 85.

The Court: You couldn't get any temperature but what somebody could complain about it.

Mr. Lyon: Are they contending that there is some significance, some infringement here, because we acidized in the summer?

Mr. Owen: No, we say that you are infringing both summer and winter.

The Court: The doctor had to take some temperature and it is fair of him to tell us what he did take.

Mr. Lyon: The point is he maintained a particular temperature in this tank by using some heat, whereas the defendant, I don't think there is any dispute, does not add any heat to its tank.

Mr. Owen: No, we don't claim that.

Mr. Lyon: It is the temperature of his tank, it is whatever it will be because of atmospheric conditions.

The Court: If he hasn't taken it at all you probably will be saying you don't know the temperature. We can readjust from that. We know and I am glad we do, what temperature he has. A. I think 85 degrees Fahrenheit is very close to the bottom hole temperature of any wells in Michigan, and that was one reason for that.

The Court: I got an idea it was a lot hotter. A. I don't know. It is sort of an average temperature.

The Court: All he can tell us is what temperature he did use. A. This acid was run into the steel tank and agitated periodically with a glass, heavy glass rod for a period of six hours. Just stirred it every fifteen minutes with a

glass rod for a period of six hours, which we felt would duplicate in some manner the contact time and the amount of agitation that acid being transported in a Menaul type tank truck would get in being taken from a storage plant to the well.

The Court: And you are stirring it also as near as you could come to the agitation it would get by being hauled? A. I don't think it duplicates it.

Mr. Lyon: I think these roads are rougher than fifteen minutes stirring out in the oil field.

The Court: But they stop and stand. A. After standing in the tank, the acid standing in the tank, the contents of the tank was then siphoned through this tubing system that we have previously described. Now, we had to, in order to get it out of the tank without running it out of the bottom discharge in the tank, we had to siphon it, and shown above the tank is an arrow indicating a vacuum supply. We had a vacuum pump connected with that, and that vacuum pump went into a large Pyrex bottle, which is shown as a rectangle just directly above the steel tank, right at the top end.

Mr. Owen: Shown more clearly on page 18, Your Honor. A. That is correct. The vacuum was maintained in order to keep the piping system full of acid at all times. It was siphoned through the piping system, but to fill up the tubing to start the siphoning action we had to apply the vacuum at the beginning and fill the entire system up with acid, and then start the siphoning action, and we had to maintain that periodically, to apply the vacuum, in order to remove any hydrogen gas which was formed during the dissolving of the iron by the acid running through it. Hydrogen bubbles would accumulate which would break the siphon action, so the hydrogen was removed through this vaccum pump, and we maintained a level of acid up into the bottle at the level mark N on the bottle here, and in that manner maintained the siphoning action continuously, and the oil well tubing was always full of acid.

The acid was run through the tubing system at the rate

of ~~100~~ one gallon per minute, and adjusted as we have described previously. The two different types of tests were made, first tests which follow the teaching of defendant's Menaul patent, U. S. No. 2,149,617. We connected the wire from the truck tank or the Menaul type tank to the tubing system to make electrical connection between the two, and ran several tests in that manner following their patent. Then we ran also several tests in which we disconnected that wire to break the electrical circuit and prevent any electrical action, and the results of those tests are described in the tables that are contained in this report.

In Table IX, run 1-M, we used the Menaul type tank and the acid was in the tank in this case six hours and 33 minutes, agitation, and then the acid was run over through the tubing at the rate of one gallon per minute, using Series 1 tubing. The average analysis of the acid leaving the Menaul tank was 3—

The Court (interposing): That is at the end of the pipe? A. That is at the inlet of the pipe. That is this steel tank, duplicating the truck tank. That is the inlet.

The Court: When you started? A. When we started up in the stoneware crock, the acid contained substantially no lead or copper, and was substantially as corrosive as C. P. acid. Then we ran it into the tank truck and agitated it for six hours and picked up lead, copper and iron, and these are the concentrations of the acid we took with that simulated truck during the run, and we analyzed for the metal content of the acid run through the tubing.

The Court: Your thought being that this was the condition of it and the content of it as at the time it started into the tubing and you are trying to show by that what you think it would be at the time it started into the well. A. That is correct.

The Court: All right. I follow you. A. (continued): 362 parts per million of lead, 4.3 parts per million of copper, and the content of the iron varied considerably during the run, and we took a number of samples out of the Menaul type tank during the runs to get more—a better

picture of the iron content because the iron is an important element in determining the amount of iron dissolved from the tubing. And so you find under the heading of "Samples Taken at the Inlet," that means acid taken from the Menaul tank just before it went into the tubing system, after it has been in there this six and a third hours.

We took samples while it was running out of this tank into the tubing, so we would get a better picture of the metal concentration, the iron concentration of the inlet acid to the tubing.

The Court: Well, now that tends to show that it was getting more iron into it. A. It picked up iron during the run.

Mr. Lyon: The rate isn't reported here. Have you got the amount of iron you found? A. Oh, yes, it is over under the heading of "Samples Taken at Inlet." You see the iron content of the tank was varying during the run. It was picked up. The acid was still picking up some iron from the tank, so we took samples every twenty minutes.

Mr. Lyon: Wasn't the copper changing, too? A. We took several samples, but the copper did not show nearly the extent of change that the iron showed, and this figure is the average of samples, and I can give you the individual or the composites of several samples that were taken.

Mr. Lyon: Did the lead change, too? A. The lead changed somewhat, too. These are the averages.

Mr. Lyon: I would like to have, so we can study it over the week-end for these different tests where there are averages and you have given only one figure—there are averages of different samples, I wish you would let me have the individual data. A. I will get those.

The Court: I know it shows a quite rapidly increasing iron content. That means iron chloride? A. That is correct.

The Court: And that means, doesn't it, that it was eating off of the tank at that rate? A. Yes, sir.

The Court: Or, at that increasing rate. A. Yes, sir. You see the commercial acid when diluted, the 15%, had

from 5 to 10 parts per million of iron. We dumped them all in.

The Court: What is there that shows how much iron there was in this when it got into the transportation tank before it— (Witness interposing): I have all those figures. They are not on this sheet. It was very low, 5 to 10 parts per million. We received no acid that had over 5 to 10 parts per million of iron. In the six hours of agitation it picked up from 1100 to 1200 parts per million.

The Court: Then one of the arguments is it did not protect that tank? A. It didn't protect it a great deal. It undoubtedly protected it over a steel tank but there was considerable amount of action on the tank.

Mr. Lyon: Could you tell us, also, in this tank whether there was any lead and copper in the raw acid? A. The analyses of the raw acid, which I have for all of the runs, show just fractional parts per million of lead and copper; all raw acid, and the iron content was never over 10 parts per million of iron, and only fractional amounts of lead and copper.

Mr. Lyon: But there was some copper and lead in the raw acid? A. There was, yes.

(Witness continuing): This acid entering the system had an average composition of 350 parts per million of lead, 4 3 of copper, and then a variable amount of iron as the run progressed. We analyzed the samples of the exit acid, the composite samples, and determined their iron content. And in the same manner that we used in the former tests of calculating the increase in iron content of the acid going through the tubing.

The Court: Now, this is the bottom of the tank? A. The bottom, second column from the right.

The Court: Comparable to when it reaches the bottom of the well. A. Yes.

The Court: I am not saying anything about how active it is, but that is the purpose of it.

(Witness continuing): And from the difference in iron concentrations and the volumes that had passed through,

we calculated the amount of iron that would dissolve from the tubing; knowing the amount that was in the inlet acid and the amount in the exit acid, the increase in iron content came from the tubing and that amount in this test was 322 grams of iron was dissolved from the tubing.

The Court: I think I know what your explanation is but that initial one again? A. Was the first gallon.

The Court: I think I know what your explanation is, but give me again why that is the highest of them all. A. Because in cleaning the tubing out there is always a few particles of loose iron it is difficult to remove, and the acid loosens those up and the iron runs down in the first slug of acid; the first small amount contains a higher amount of iron, usually, than the rest of the acid. Now, it is not essential that that be the case. In other words, it comes out when we clean the tubing. As I said before, it is impossible to clean out 112 feet of tubing.

The Court: What was in there you didn't clean out was free iron. That wasn't iron ferrous chloride? A. It was free iron but in a very small particle form and by the time it got down to the end the acid had dissolved it. We never could detect any metallic iron in the exit acid.

The Court: What is your explanation as to why—why is it we find an increasing one following that? A. I don't know. In this particular case in this one 1106 at the beginning, possibly we had removed all that fine iron dust out of the sample tube and had done a particularly good job of cleaning, whereas in the other test maybe we hadn't done that and a small amount remained in there.

The Court: Now, you have two columns for the iron there. Now I get the same sort of results. Or am I too far into what you are explaining? I get the same sort of thing away over in the last column for the iron in the sample taken out. I find the original one is large, which I take it you explain in the same way as you did the other, and then I find it increasing again down there. A. It increases because the inlet acid is increasing in iron concentration. You see, the iron from the tank—

The Court (interposing): But this is increasing. Let me see if I am right or not. A. The first one is 370, between the first composite in and the first composite out. The next one is 217, and the next one 410.

The Court: It goes up and goes down and goes up. Have you any theory at all about that? A. I don't know how to explain it. I haven't any theory for it.

Mr. Wiles: Were those samples the same size? A. Substantially the same size.

Mr. Lyon: Your Honor has referred to that before. I would like to give you some assistance on that. Isn't it true that same action is usually found in corrosion of a hydrochloric acid on steel—that it goes in waves? Have you made any tests of that kind? A. No, but the question was asked me yesterday why the amount of iron dissolved was low at the beginning of the test and then it rose up and fell off. The reason in that case—I just happened to think overnight—could possibly be the tank acid was 85° F, the tubing was 72 because it is in a thermostatically controlled building, and when the first acid went through the tubing it wasn't quite up to the temperature so the rate of corrosion was kind of low. When the tubing got up to 85, the rate got up high and the lead and metals in the acid are doing their inhibiting action by forming a minute film of molecules of this stuff, and then tend to drop down as you went along.

Mr. Lyon: That might be a possible explanation but I don't think the witness advances it as necessarily the one. I think it is only fair to state, Your Honor, there is no point about it in this lawsuit and the witness evidently hasn't studied it, but wherever you study corrosive action of hydrochloric acid on steel it seems, for some reason (that has nothing to do with this lawsuit) to go in waves. It starts at one figure and either increases or decreases, and then goes the opposite way and does it in waves, for some reason. It has nothing to do with this lawsuit. But it seems to puzzle Your Honor, so I thought I would make that explanation.

The Court: Another thing, as to columns 5 and 7 I

should keep this in mind, shouldn't I, that in column 5 we are dealing with a solution that has remained right in that transportation tank. To use the metaphor here that you want me to use, all the while, you first take out some; now the action is going on with the rest while it stays in there, and the last it has had more opportunity to work on it and therefore I would expect a little increase along there if there was any action at all. Now I come over here to column 7 and I have an entirely different proposition and I mustn't apply that thought to it at all because that acid is going on down through and I have nothing to account to me at all as to why the first that goes the whole length of that pipe should have any greater change on it than the next that flows the whole length of the pipe. They are quite different, so far as that is concerned, column 5 and 7, isn't that right? A. They aren't a great deal different.

The Court: I mean in the first one, if I am drawing cider out of a barrel that is getting hard, and I only draw it at different intervals, the last I draw out ought to be harder than the first. A. Yes.

The Court: Now, I haven't any such theory I can apply to column 7 at all. I find nothing in that because it didn't take any longer for one part of it to flow from the top to the bottom than it did the other, you see? A. But in flowing through this pipe it is picking up iron and the thing we are noting here is that apparently the rate of picking up iron does vary during this run.

The Court: Yes. But I say you can't explain that on the theory (it may be a poor theory) that the longer it stayed in there the better chance it had to get iron. While in column 7 it wasn't in contact with the iron any longer than the last batch with the first, while in column 5 the last batch was in contact with the iron longer. A. But there are peculiar things happening in this pipe that are beyond my ability to explain to you.

Mr. Owen: Well, I made some figures here, Your Honor, that seem to me to be entirely consistent with the increase in the amount of iron in the inlet samples. That

is where it is going in, the fifth column. I take the second figure there of 1200 and I find that the outlet, the corresponding outlet samples increased 370 grams of iron, and the difference between the next two is 417, and the difference between the final sets is 410, so it seems to me that increase in the outlet column is accounted for almost entirely by the increase in the iron in the inlet column.

Mr. Lyon: No. A. The difference is closer than the figures I estimated. I made some mistakes in substraction.

Mr. Owen: 370, 417 and 410.

Mr. Lyon: The court calls attention to the one above that and the fact there is a drop from the first one and then it starts going up and then it starts going down again. A. That has nothing to do with the test. That simply has to do with the cleanliness of the pipe at the start and the first gram or two of loose iron in this inlet. In the initial tank sample that first gram was taken directly out of the tank and therefore should be below the samples that were taken as existed in the tank, so 1106 should be lower than 1200.

Mr. Lyon: Why shouldn't there be the same difference at each one of these stages? A. It is, except the initial out.

Mr. Owen: And that has been explained several times.

Mr. Lyon: The first stage of comparison after that initial you say is 370, the next one is 417.

Mr. Owen: Yes.

Mr. Lyon: Why shouldn't they both be the same?

Mr. Owen: Your Honor, I think we ought to postpone the cross examination. We don't seem to be making any headway at all.

The Court: I agree with you.

Mr. Owen: Now, Doctor, this Table IX you say in column 2, "Menaul method acid and special tank." Will you explain what is the significance of the term Menaul method there? A. The Menaul method is as described in their patent, which involves the forming of a galvanic steel by electrically connecting the truck tank to the head of the well, or the tubing, and that method was employed here of electrically connecting the truck tank with the top of the tubing.

Mr. Owen: And that, I will state, is or was the defendant's practice, Your Honor, in the three wells from which samples were taken. They connected the truck tank to the oil well tubing by a copper cable, and their contents—

The Court (interposing): Any battery now mixed up with that?

Mr. Owen: No battery, no, except that this lead plate in the iron tank, and the acid as an electrolyte, in itself forms a galvanic cell. That is right, isn't it, Doctor? A. That is correct.

Mr. Owen: But there is no outside battery, no external electromotive force there.

The Court: Except as the tank itself, with the acid, forms it?

Mr. Owen: That is true. Now, explain your next table, Doctor, Table No. X, and at the outset explain the first statement "Menaul Method No Wire Connected." That means, does it not, that you duplicated the other test as closely as you could, but did not connect the wire in Table X test but you did connect it in Table IX. A. That is correct.

The Court: And IX and X you run just alike except for that, is that right? A. That is correct.

Mr. Owen: The purpose being to show, Your Honor, that there is nothing in this connection between the tank and the tubing.

The Court: I see. In this test, the acid was agitated for 6¼ hours in the tank. Series 1 tubing was used. The average analysis of the inlet acid was 158 parts per million of lead, and 3.25 parts per million of copper. That is considerably lower in lead than the sample before and somewhat lower in copper.

Mr. Lyon: About 25 per cent lower.

The Court: And agitated the same length of time and agitated in the same way? A. As closely as we could. And samples of acid from the steel tank were taken at 20 minute intervals, and the composite samples analyzed for iron. That is shown in the fifth column, the figures for iron

of inlet acid. In the seventh column are the figures for the exit acid from the tubing system, when the increase in iron content in acid due to the dissolving of iron from the tubing is figured, 330 grams of iron were dissolved by the acid. In other words, we got exactly the same results with or without the wire connected.

The Court: You have got intervening figures that are quite different, aren't they?

Mr. Lyon: And I call Your Honor's attention to the fact that there was only about half as much lead in the second sample as there was in the first, and 25 per cent less copper.

The Court: Less copper.

Mr. Lyon: Yes, 25 per cent less copper. A. I think it has been shown here that changing copper from 3 to 4 parts per million makes little difference.

The Court: But what I was wondering, how did you get so much less lead and one-fourth less copper if you took the same acid? A. Yes, the same original acid.

The Court: I am wondering and I was carrying the thought that there hadn't anything at all happened up to the point of starting that could be different. You took the same crock. A. That is true.

The Court: You took the same acid and everything. Why do we start away from scratch with such different figures? A. Agitating by hand is a very variable procedure, Your Honor.

Mr. Owen: Which run was made first, Table IX or Table X? A. The first Table IX was run first.

Q. Well, might not the larger amount of lead and copper in the Table IX run as compared with them in Table X run be accounted for by the fact that the first batch of acid you put in that tank ate off the lead from the walls of the tank? A. That is the explanation.

The Court: But I thought that was when it went into the tank? This is before it has had time to eat. A. It is after it has been six hours in the tank.

The Court: This is? A. That is the acid before it goes into the tubing.

The Court: This 352? A. 362.

The Court: You did have them just alike when they went in? A. No.

Mr. Owen: When they went in the steel tank, they were just alike.

The Court: That is what I mean. A. You have four runs that we made in this tank, a steel tank. It was polarized once, and the first run made in it, the lead was 362 after standing. The second run that was made in it the lead was given at Table XI, and it is 291, so it follows—

The Court: Which is the second now? A. The second run in chronological order is XI, which is 291, so it fell from 362 to 291. Then the third run is this one that we have here, and the fourth run is in Table XII, so—

Mr. Lyon: Were there any intervening runs? A. There were no intervening runs.

Mr. Lyon: These are the only runs you made? A. Yes.

The Court: Table XII is the fourth one? I will see if I get it in series at all. 362 and 291 and 168, is that it, and then 247? It jumped back up again. A. It jumped back up again.

The Court: I was wondering that would go down so I could have some theory? A. Taking a tank and agitating by hand is quite a variable thing, and it can vary 25 per cent, and that particularly applies to the lead concentration, and it is more difficult to dissolve in solution, just as we had trouble in dissolving lead chloride, and it depends on the agitation you get.

The Court: I don't know. I better follow that one. The first one was high because it was so—because it was the first, and there was more lead coated on? A. On the side of the tank.

The Court: Because my fourth one jumps way back up, which had from that standpoint the poorest chance of all. It was the furthest away from the battery plating of the wall, isn't that right? A. That is true. There is a considerable variation that you will get in lead content.

The Court: A witness when he performs his experi-

ment, he gets something he can't explain or I can't. I am glad to have you bring it to me just as you get it. Give me those in their order. A. 362, 291, 158, and 247, I believe.

Mr. Lyon: Now, Your Honor, I suggest you get the order of the copper contents too in the same arrangement, see how they vary. You have been looking at the lead. Why not look at the copper?

The Court: Well, all right. Give me those, Doctor. A. The first one is 4.3, then 2.88, 3.25 and 2.32.

Mr. Owen: Now, Doctor, will you explain, or had you finished with your explanation of Table X?

The Court: Go ahead. I will tell you all I haven't any theory, and I am waiting for you to give me one. A. Yes, I think I have completed Table X, in which we got substantially the same result as we had with the wire disconnected as we got with the wire connected.

The Court: When you got over to the final result they come out surprisingly close? A. That is right.

The Court: But they travel quite different roads to get there, as I see it? A. Yes.

Mr. Lyon: That is why I am objecting to these averages.

The Court: Well, all right.

Mr. Owen: Take up Table XI now, Doctor. A. In Table XI the run number is 2-M, and this again is the practicing of the Menaul process, with the wire connected between the tank and the oil well tubing system. The same temperature and rate of flow of acid was used.

Q. The same series of tubing? A. The acid was in the special tank for seven hours in this particular case, and series 2 tubing was used. The average analysis of the acid in the tank was 291 parts per million of lead and 2.88 parts per million of copper. In column 5, under samples taken at the inlet in parts per million of iron are given the iron concentrations of the acid in the steel tank at various times during the run. In column No. 7, under samples taken in the acid in parts per million of iron in the exit acid are

given the figures, the concentrations in parts per million of iron, and the acid leaving the tubing system at various times during the run. Calculating the increase in iron content in the exit acid over the inlet acid is 265½ grams of iron dissolved from the tubing.

Table XII, run 2-N is described. A Menaul method tank was used. The acid was placed in the tank for 6 hours and 30 minutes. The temperature was 85, the rate of flow was a gallon per minute, as before, but the wire was disconnected. Series 2 tubing was used. In other words, the same tubing as was used in 2-M, described in Table XI. The average analysis of the inlet acid was 247 parts per million of lead, 2.3 parts per million of copper.

The acid leaving the system,—the inlet acid in the storage tanks, in the steel Menaul tank was analyzed at various times during the run, and those figures are given in column 5, under samples taken at inlet, parts per million of iron. In column 7 are given the parts per million of iron in the exit acid leaving the tubing. From the increase in iron content of the acid and the volumes passed through, we calculated the amount of iron dissolved from the tubing, and it is 195.7 grams. In other words, it is somewhat less corrosive in this particular test with the wire disconnected than it was in the test 2-M where the wire was connected.

The Court: Do you attribute it to the disconnected wire? A. No, I attribute it to the possible variations in our test conditions. I don't believe it makes any difference whatsoever. I think the result should be the same.

The Court: There is a substantial difference though? A. 265 to 195 is 70 grams difference.

The Court: That is put in millions? A. That is grams of total iron dissolved, 265 grams of total iron dissolved. I don't believe the wire makes any difference, and that these tests would indicate that there was any appreciable difference. The first two comparative tests indicate the same result and the last two indicate the disconnecting of the wire gave somewhat lower corrosion. The main purpose of the test was to show that the wire doesn't materially change,—

decrease the rate of corrosion by connecting that wire, which is necessary to practice the Menaul patent.

The Court: There is a difference of 36, isn't there? A. Yes, a difference of about 70 grams of iron.

The Court: That is quite a difference. Isn't that a large amount? I don't know. A. When you take raw acid and run it through this tubing we dissolve 1000 grams of iron, and here we have a difference of 70 grams.

The Court: One would indicate 70 per cent less harm than the other, or 30 per cent less harm than the other. A. I would be willing to concede the disconnecting of the wire actually improved conditions. I would be willing to consider that.

Mr. Lyon: We are not talking about that. Tell him how much inhibition it decreased by disconnecting the wires, or per cent, as compared with the wire connected, in what per cent have you reduced corrosion, on your own figures? A. We have reduced the inhibition of the acid by disconnecting the wire.

Mr. Lyon: By how much per cent? A. By 7 per cent, approximately.

The Court: More than that?

Mr. Lyon: Sure it is more than that.

The Court: You have 265—

(Witness interposing): No, I stated it in the opposite from the way you stated. I stated the reduction in corrosiveness or the inhibition in coming from 1000 grams down to 265, there is 750 grams of iron difference; if we reduce it to 195 there is only another 70.

The Court: You reduced it more than before.

Mr. Lyon: That is right. A. In corrosiveness. I said inhibition—

The Court (interposing): But say you have reduced the corrosion more than 25% by this. You don't claim it did, I don't claim it did.

Mr. Wiles: When you have it pretty well inhibited, for instance a 99% inhibition, and raise it to 99½, it is true there is a difference 50% in corrosion but practically you have no corrosion in either case.

The Court: All right. But you have reduced the amount of corrosion by more than 25%.

Mr. Wiles: That is true, but you have started out by reducing it down to a very small amount in the beginning.

The Court: Sure.

Mr. Owen: Your Honor, in considering this particular question you should go back to the tests made from the stoneware crock with uninhibited commercial acid. Those showed in Table I a total grams increase in iron of 1043.

The Court: I follow you that you say neither one of these are corrosive enough to do any harm. That must be the contention.

Mr. Wiles: They are very greatly improved in that respect.

Mr. Owen: They will do some harm, they are not perfect.

The Court: Then when it was disconnected it did change it more than 25%?

Mr. Owen: I don't know whether the doctor has any theory as to why there was less corrosion with the wire disconnected than there was with it.

Q. If you have a theory, I would like to hear it. A. The theory of electrolytic protection by galvanic action is interesting from a theoretical standpoint of connecting a metal which will dissolve more readily than iron to the iron and many people have tried to apply that in actual cases and have found that instead of getting inhibition they get the reverse. They get more corrosion when they connect things together like that, and particularly if they try to impress potentials upon a metal. I don't know whether this would be an instance of that case or not. As far as I am concerned, I would be willing to say both on the results of these tests and from my theoretical knowledge, that this connecting or disconnecting the wire would have absolutely no difference—it would be a small amount on the inhibition.

The Court: I get this from what you say. You performed many experiments before you reached the conclusion this connection of the wire was the cause of the

change? A. Yes, I wouldn't expect it to be of very great difference one way than the other.

The Court: I say you performed a good many experiments before you reached a conclusion. A. The results of these tests indicate to me substantially there is no inhibition produced by that wire connection.

The Court: Of course that is the danger. I agree fully with the explanation that that was less destructive—the acid was to iron, when it was disconnected than it was before; I wouldn't want to reach that on just one experiment. And I understand you clearly to say you don't reach that conclusion on one experiment. A. No, these experiments should be considered with the tests that I ran before. In describing those tests I mentioned that the first two tests I duplicated the composition of the acid in the steel tank and ran it directly from the stoneware crock to the tubing system; not only disconnecting the wire, not even having the lead plate in there in those tests we got exactly the same results with the wire connected or disconnected. In other words, six different series of tests, all duplicating, all pointing to the fact that the lead plate, the wire, the tank, has no effect on inhibiting corrosion in an oil well, and that also agrees with all theoretical principles of electro-chemistry.

Mr. Owen: Doctor, while we are on this subject, I would like to have your theory of the Menaul proposition that the pipe can be protected from corrosion by connecting up the tank to the pipe by this cable. A. The theory, as I explained it, in agreement with these tests, as to why the tubing is protected when they practice the Menaul patent is simply due to these metals which are added in the acid and which are fed the acid containing those metals, fed into the tubing. That accounts completely for the inhibition. The placing of a lead plate in a steel tank at a position electrically remote from the bottom of the well, or even inside the tubing, from a consideration of electrical circuits is that you might get some little inhibition on the end of the pipe that is sticking into the tank, but in any

circuit the electrical current takes the easiest path that it can to go through the circuit. It doesn't go through all the way to the bottom of a 2000 foot well, jump to the pipe and run back. If you have an electrical circuit and have two resistances connected between two bus bars, one resistance has a very high resistance, the other very low; all the current goes through practically the low resistance. There is no reason as to why the current should go down the acid through the tubing, to the bottom, jump across the tubing, back through the tubing, back to the tank as described in defendant's patent, and in that way protect the tubing.

Q. I wish you would trace that circuit as described in the Menaul patent down into the well and then back to the tank. A. They do describe in the patent one method of operation which would have some remote change of working, but which is so impractical that I don't believe it was ever even tried out, and that is to lower a lead wire down to the bottom of the well, keeping it from touching the sides of the tubing, and pouring acid down between the lead wire and the tubing. Under those conditions, you might get a little bit of inhibiting effect. But with the lead plate back in the tank and the circuit that you have to follow—if I may draw on the board here, I would like to draw it.

We simply draw a vertical tube in the ground, that you can visualize as being a couple of inches in diameter and several thousand feet in length, and that tube is full of acid. Then we connect that into a truck tank, and here is the truck tank, in some shape or other. In the bottom of this tank is this lead sheet and more or less lead covering the sides. The iron is partly exposed. There is definitely a tendency, a potential, which would make the lead negative as compared to the iron tubing, and a galvanic cell which you might figure would take some lead and plate it upon the iron. Now, between the tank and the head of the tubing there is a copper wire connected. Steel to steel, the tubing and tank. We have a circuit.

The Court: Each filled with hydrochloric acid. A. That is true. This is all acid. Now, we have a cell in which

this is one electrode, the electrolyte or solution in the cell between the electrodes is hydrochloric acid, and this whole system is another electrode. The whole system is one electrode. Now, the passage of current between two electrodes in a cell, the current goes in the most direct manner it can. Now, the actual voltage of this cell, as will be shown possibly by the defendant, or we may bring it out, is on the order of a few hundredths of a volt.

Mr. Owen: I may read from some of the defendant's literature where they stated the voltage of the battery formed between the electrodes is ".35 of a volt. Therefore it should be a good conductor and as little resistance as possible in the short circuit so that this low voltage current can readily flow from one point to the other."

The Court: Now, this copper wire across there just hitches two irons together. A. Two metal plates together, and in between you have acid.

The Court: How is it any different than as though here you had a tank over there, and the pipe coming right immediately connecting to it? In other words, are all of you—I don't know, maybe—are any of you claiming that that makes it different than as though this was steel across the top and that just fitted right to it and came right around and it was all steel and all filled with acid around here? Does the fact that that is an open space there and this has copper across, does that make it different? A. It makes some little difference, but not appreciable. It is the same as you have in any type of battery where you have one electrode, like a carbon rod in an ordinary dry cell, that is the one electrode in the cell, that is the solid conductor, and then the other electrode in the dry cell is zinc. In between you have a thick solution of ammonium chloride. That is a typical battery. And you don't get that battery to function unless you connect it electrically outside. In other words, the dry cell just stays without acting until you touch a wire across here, or put a flash-light bulb across here, and then the current flows and then these actions take place. You have a complete circuit here with electrical current flow-

ing through the cell. And the light lights up. Now, the same thing is true here. If we have that disconnected, and the other connection, if we had this welded across here, we would have the same sort of condition.

The Court: That is what I thought. A. And the passage of current between.

The Court: Here you had your typical one, and you point out to me that you have one zinc and the other— A. (interposing): Carbon. One zinc in the dry cell.

The Court: Carbon and zinc here. A. Where we have this.

The Court: Lead is plating on one of them. A. Yes.

The Court: And to the other. A. The iron of the pipe, the tubing, is the other, all the way down the well. Now, the current flowing between these two electrodes passes through the path that has the least electrical resistance; it takes the easiest path out. It has to go through the acid, and, therefore, it has to go through the acid to the pipe, from the pipe back through the electrical wire and back around in this sort of a circuit, but if here the current went around in this direction and completed the circuit with this outside wire, we have a complete circuit.

The Court: You haven't got that hitting the lead at all. You have got to have that current go to the lead. A. I assume this was coated with lead. So the current comes from here, to here, back through the wire and back to here. There is absolutely no reason why it should take a path and run through the column containing solution for three thousand feet of a very low, poor conducting solution, three thousand feet, jump to the side of the tubing down here, and then run back throught this pipe.

Mr. Lyon: Well, just assume that the entire side of the tank is coated with lead, and go ahead with your proposition. A. The inside of the tank?

Mr. Lyon: You can't have current flowing from lead to lead. A. You have exactly the same condition.

Mr. Lyon: You can't have current flowing from lead to lead. The current will flow to the nearest iron. A. If

this tank is completely coated with lead, as you state, and as I believe is your contention here—

Mr. Lyon (interposing): Yes. A. Substantially so.

Mr. Lyon: It is completely covered. A. It is completely covered. There is no iron exposed in the tank.

Mr. Lyon: You can't flow the current from the lead plate to the lead covered wall. A. There is subsantially no current flowing from the lead plate to the lead covered wall.

Mr. Lyon: The current will try to flow from the lead plate to the nearest uncovered iron. A. I have exactly said that. It would flow from the lead across here. I consider this whole tank a piece of lead, because this is substantially coated with lead. That is all lead. Now, the current flows from this lead inside the tank to this tubing. But it flows through the shortest path of acid it can flow through, because it doesn't want to go through a long path of acid.

The Court: That sounds reasonable. A. Therefore, it doesn't go down to the bottom.

The Court: As I understand it, he is asking you to assume that that is all coated. A. That is all lead.

The Court: All right. Where will it go to? A. It goes from the inside of this tank, any place from the lead on the inside—

The Court: That is all lead. A. That is all lead.

The Court: Now, where? A. It goes to the end of the tubing.

Mr. Lyon: When that gets covered with lead, what happens?

The Court: That is what they (defendant) will claim, I suppose. They haven't said that, but I take it the theory is—and I want you to knock it out if it ought to be—I take it their theory is that that will go to the end of the tubing and it will coat that, and then it will go to the next nearest and then the next and the next.

Mr. Lyon: That is right. Theoretically, that is the basis of the engineers' reports on this.

The Court: And I think—they don't claim that it

would, while that is all open, run the whole length of the gamut and coat it all through.

Mr. Lyon (interposing): No. A. It would have to eventually run the whole length of it and do that plating at some time, by their contention. It is not possible to take a metal, a pure metal, suppose we take pure lead, and put it into a solution—let's take hydrochloric acid—and not take any other kind of an electrode over here, it is not possible for that lead to dissolve itself and then also to plate itself out in a continuous sheet on the other electrode without adding some voltage externally, no more than you can lift yourself by your boot-straps. The energy that this lead gives off in dissolving is required, and an even greater amount of current is required to plate lead from this pole onto this other electrode. It hasn't enough kick to plate a complete film of lead on this surface. So there is possibly a molecule here and there, scattered around. There is some very slight amount of plating, but you get that same kind of plating when you immerse iron in a solution of a lead salt.

The Court: The thing you are meeting—you don't have to meet the claim that it would start some plating down at the end immediately, down at the bottom immediately when you started, as I understand, because that isn't what they claim. But they do claim, and what you are meeting, is that it would not have enough energy left to even plate the tank, so it would never get through plating the tank? A. That is why they put the battery in, to get the plating on the tank.

The Court: And you claim they don't get sufficient—am I stating your theory and contention correctly about this, that it never does get far enough along so that it even gets the tank, out of which it is flowing, plated, and therefore it never begins to plate the pipe? A. It partially—this voltage or potential energy the lead has contained in dissolving is used and there is a slight tendency to plate out lead on this coating, but the amount of lead plated out is an atom here and an atom there, and very imperfectly cov-

ering it. In order to get a complete covering, they want to use a six volt battery, and you must remember we are talking about voltages on the order of a few hundredths of a volt here. And when they want a complete coating to protect their tank, they connect it to a six volt battery to help out the lead solution. If you take an ordinary lead solution, or a lead salt, and immerse iron in that, some of the lead will deposit on the iron. A very minute amount. If you put a few hundredths of a volt on, you get maybe a few more atoms of lead on. But to get a complete sheet of lead plating on a surface, you have to place some external voltage on it to do that.

The Court: It is my understanding that you say that in this weak battery it will never, the lead will never so completely cover the steel walls of the tank, and the little end of the tubing that stands down into it, so that there will ever be any current passing on the well side of the point where the copper wire is connected to the tubing? And it will always turn towards the tank side of it and go round and round in that side and that it will never, the tubing, get coated down beyond with lead, beyond the connection to the copper wire in such a way that the current will turn towards the well, and so down the tubing and then come back through the solution? A. The amount of any current that flows down here is substantially negligible. We have actual measurements of the current that flowed through this wire in our test, and it is in the order of millionths of an ampere that flowed, even here, and to express how much it plated down.

Mr. Lyon: What order of current density is required to plate lead on steel, what order of current density? It is in the order of a millionth of an ampere, isn't it? A. Current density has nothing to do with it.

Mr. Lyon: You made a measurement of this current and it is only a millionth of an ampere. That is all the current that is required to plate lead on steel, isn't it? A. There is quite a bit of information in the literature on the electrolytic protection of pipe lines, and this is an electrolytic protection.

Mr. Lyon: Can you answer that question? A. I don't have any information. I am telling you for electrolytic protection practiced commercially on pipe lines the current required is tremendously greater than a millionth of an ampere.

Mr. Lyon: Do you know whether or not current in a millionth of an ampere is sufficient to plate lead on steel? A. I can't tell you that, because the quantity of electricity flowing determines the amount of deposition of hydrogen and lead, which are two things that are simultaneously deposited and the conditions that you would have would vary greatly, and I don't think it would be possible to measure it, unless you measured a tremendous number of tests, and it is so far below any commercial figures given for electrolytic protection. Then it violates the deposition of electrical circuits, and also the tests that I have run here quite definitely prove that its electrolytic protection is absolutely of no value.

Mr. Lyon: I am trying to get you to tell us whether in accordance with your theory that there was no appreciable continuous plating in the defendant's tanks due to the presence of that bonded lead plate, if it would make any difference in the life of the tank whether or not the bond between the lead plate and steel wall was broken? A. I have said that you get some electrolytic protection in that tank, I believe. I have no tests to indicate otherwise, but I believe, and it is entirely reasonable that you would get some protection, that this lead would definitely have a potential which would tend to put molecules around on the surface and exert some little protection. Just how much I can't tell you, but to get thorough protection apparently you have to go to very high voltage, an added voltage, which will coat the surface over, practically continuously with lead.

The Court: I understand you, Doctor, to say that whatever the conclusion may be about protection given to that tank, if I go in there 5000 feet there is absolutely no electric current resulting from that lead? A. That is my contention.

The Court: Now, then, I have got the idea that you say that for practical purposes there isn't any of the other side, copper wire connection on the well side that the current starts from, where the copper wire connects to the tubing, and makes its way back through the solution on the tank side? A. The positive flow of the current is in the direction through the walls of the steel tank, through the lead coating on the inside, across the acid and it comes to the closest point on this metal tubing that it can, the current passes through there, and then back around in that direction, any current.

The Court: It never goes any further towards the well than where the copper wire connects with the tube?

Mr. Lyon: I would like to correct that. In your explanation it wouldn't make any difference where the copper wire from the tank was attached to the pipe. That hasn't anything to do with it? A. That has very little effect.

The Court: But you haven't any of you gotten what is bothering me. I understand the doctor to say that wherever you attach it, and I agree it doesn't make any difference, but that when it comes in contact with that tubing that it never goes any further towards the hole in the well, but its course leads back now into the tank? A. That is the main circuit, and the amount of current that would flow—there would be very little current that would flow, very little.

The Court: Now, how far, that is what I am getting at? A. It wouldn't flow, in my opinion, any distance at all, and the amount is so negligible—

The Court: In feet how far? A. I couldn't tell you. You can't calculate it.

The Court: You know it wouldn't be 5000 feet?

Mr. Lyon: You don't know that. A. It is my opinion it wouldn't go twenty feet.

The Court: Well, now, that is what I wanted to get at. A. That is my opinion. I can't prove it, but that is my opinion.

The Court: You could pull one of these things out some day more than twenty feet.

Mr. Lyon: He said that was his opinion and he couldn't prove it.

The Court: I know it. Maybe you can disprove it.

Mr. Lyon: I am not claiming I can. A. We haven't any proofs on that, I mean in the small set-up we made with our tubing system connecting the wire, we found where the tube,—where the wire was connected was inhibited. We had 112 feet in this tube system that we have and we measured the loss in weight of each length of tubing, and even the length where the copper wire was connected wasn't inhibited, so I say the amount of current that flows is not enough to do any good. The fact you can break this steel completely and take this whole thing away and get exactly the same amount of iron dissolved all is evidence.

The Court: It is my understanding of your testimony that the underlying reason for that is that it is your belief and opinion that this iron in the tank, not to exceed twenty feet of the end of the tube, never gets enough coated with lead, so by what it has all got, it has got enough iron to satisfy its appetite right there? A. That is right.

The Court: Isn't that the meat of it all? A. That is right.

The Court: And their contention, evidently, from this, because I feel so right about it, is the fact you wouldn't start at the bottom of the well, if there wasn't any necessity for it,—you don't take a great big detour unless the road is bad straight ahead, but their contention, as I understand it, is that they have got a tank that is coated so much it doesn't satisfy its hunger for that, and begins at the end of the tubing and rapidly goes down coating the tubing and in that way protects it.

Mr. Lyon: May I state the proposition? Our proposition is that we use this Menaul method to protect our tanks.

The Court: Yes.

Mr. Lyon: Our theory considers there is a good possibility that it may do some protecting of the pipe, but it is

purely theoretical whether it does or not, and there is no way in the world of establishing it one way or the other.

The Court: As long as they claim their purpose is to coat their tank, that is what they say, that is, that is what they say their purpose is, and it does give protection to it?

Mr. Lyon: We will prove that.

The Court: I will ask the witness right now, what do you think about that? A. Does it give protection to the tank?

The Court: Yes. A. It gives a slight amount.

Mr. Lyon: You don't know if it is more than that? A. I don't know. We have run tests in the laboratory against steel and it might inhibit the corrosion 30 to 50%, or something like that. It would vary with the conditions. Then you plated this battery to get more lead on this and that—

The Court (interposing): I haven't a very big dispute about this thing.

Mr. Wiles: The tank hasn't anything to do with the lawsuit any way.

Mr. Lyon: I think it has this much to do, Your Honor. Somebody said our use of this method was a smart trick in order to do something down the well.

Mr. Wiles: I say it is.

Mr. Lyon: That isn't the purpose of it at all. It is to protect the tank.

Mr. Owen: I would like to have the witness retrace that circuit in the defendant's tank when it is connected up with the oil well tubing by the copper cable. In tracing the circuit, Doctor, although you are illustrating it on the blackboard, please make your description perfectly clear so that when read from the record it will be understandable? A. The tubing which may be simply dipped into the tank, or which may be connected through some pumping arrangement at the bottom of the tank, is electrically connected by means of a cable at the side of the truck tank; and, therefore, we will show here a copper cable connecting the oil well tubing to the outside of the steel tank.

Now, this steel truck tank has on its bottom a thick

sheet of lead, which is connected to the tank, and then due to their preparation of the tank by their so-called polarizing method, they put on a thin coating of lead on the side of the tank, and so we have a steel tank with the bottom practically covered with a heavy sheet of lead, and the inside of the walls of the tank partially covered with electroplated lead.

In the tank we have our hydrochloric acid for the acid treatment. Now, we will assume that this tube is full of the fifteen per cent hydrochloric acid, which it would be in case we were transferring it, possibly, through a pump or some other means from the tank down into the well.

The Court: Now, I am thinking of that, and see if I am wrong, I am thinking of this as one continuous body of hydrochloric acid. A. That is correct.

The Court: I am thinking of the steel as one continuous body of steel, and I am ignoring the copper wire. That is simply a little bit better conductor stuck in there, and I am thinking of this as this odd shaped thing running down there and all of that, but I am thinking of this as a solid bit of steel with all that connected across there, of course. A. That is right.

The Court: Just as if the steel ran across. And one big spot of lead down here in this, and the sparsely settled lead sticking up there. A. That is correct.

The Court: That is the idea I am carrying about that outfit. A. That is exactly correct. And if you imagine that down this well you are about one to three or five thousand feet away from this lead plate, so that this end of the steel tube in this example would be several thousand feet away from here. Now, the operation of this cell is that the lead goes into solution and current passes from the lead into the solution. Tries to get to the iron. It will go to the iron that is closest to it.

The Court: I would think so. A. In other words, the current from this lead would go to this iron. In order to protect down below here, the current has to pass from this lead sheet, up through the pipe, through the acid, always in

the acid, down through this column of acid, then come to the wall of the pipe and to its protection and then back through the wall of the pipe, back through the copper wire, back into the tank, to the lead plate.

The Court: Yes. A. In other words, in this example, which is a simplified diagram, the current goes from the lead into the solution and then travels in varying amounts to the iron surface closest to it, or to the iron surface three or four thousand feet away from it.

My contention is that the amount of current that passes from this lead electrode or sheet to a point a thousand feet away is substantially zero, since we have measured the amount of current that passes between this whole tubing system, the entire tubing system and the tank which we had in the laboratory, and the amount of current was on the order of a few millionths of an ampere, particularly in that the resistance of this hydrochloric acid is considerably greater than the resistance of the metals, and therefore there is absolutely no reason why current will take the hardest way to go any place. That is simply a law of nature. It would take a long while, and a fairly appreciable amount of current at least something greater than the order of a few millionths of an ampere to cover a thousand square feet of surface with any protective coating into the well.

As a result of the tests which we have run, when we broke that circuit, which prevents that action, when we broke that we got a little better action than we had with the wire in there.

And as I told you before in this applied electrolytic protection, there are just as many examples where electrolytics work in a negative manner than in protecting the metallic surfaces, and therefore the statement that I would make from our tests is that the wire had little effect, the electrolytic protection had little effect one way or the other, and I think that is what I stated last Saturday. And then the other argument, the difference in potential that existed between this tank and the tube in our set-up was down in the order of one or two hundredths of a volt. The difference

between this lead plating side of the tank is a little greater than that, I will admit, but the potential difference is so slight that any protective action that you would get, the tendency to plate lead out is negligible, because that plating out requires a different potential. In the surface of ordinary steel pipe differences in potential occur between different parts of the pipe. That is, if you take a piece of pipe and expose it to hydrochloric acid, or any water solution, differences in potential between particles of the steel and the iron crystals of the ferrite amount to as much as several tenths of a volt.

In other words, down at the bottom here we have little cells where a particle of iron carbide and a crystal of iron in close contact have potentials of one to three-tenths of a volt, and those little cells will have much greater voltage than you have impressed on this whole system, and therefore the surface of the iron pipe has a small galvanic cell, and those small galvanic cells,—take your inhibitor, which is plating solution in copper, and plate out the metal without any external action. They will plate out a small amount of lead and copper. That is the way the lead and copper acts as inhibitor. It doesn't need this outside current.

It has several tenths of a volt out in the open. A piece of pipe in the open with hydrochloric acid, or any water solution, on that surface there are differences of potential several tenths of a volt. We have that potential and we put a solution with a little bit of lead and copper in it. The current in that little galvanic cell causes the electrical chemical cell action and plates the lead on one of those electrodes.

Now, if we impress another one hundredths of a volt of copper from some source outside, say three thousand feet away, and with a resistance between it, we are not going to get any greater effect or any protection on this metal in solution, and therefore the metal in solution combined with the differences in potential that exists in the steel itself, the lead plates out to some degree, the copper plates out quite thoroughly, and you get a protective film formed on the

surface of the iron just by immersion of the steel in this lead and copper containing solution.

The Court: Well, lead chloride and copper chloride, do they have the possibilities for the little electric current just the same as the free copper? A. They are somewhat different in that you plate on a perfect film of lead, it doesn't act quite the same way as a sheet of lead. That is 100% lead, and you get a definite voltage or the tendency for that lead to dissolve but if you just partially cover it with a few atoms, you don't get quite as high voltage.

The Court: Is this plate we talk about of lead free lead just like our lead plate is when we start or is that coating like the particles that are floating through the acid and really lead chloride? A. It is metallic lead. It is small particles of metallic lead, and it isn't lead chloride.

The Court: Well, now as it is, on its way across that, of course, has its origin in the lead plate and it winds up as a thin coating some place at a little or great distance. On its way over there is it free lead or lead chloride? A. It is a lead ion with a valance of two and an atom of lead with two electrons removed from it. Completely different.

The Court: It is hooked up— A. With chloride.

The Court: That is on its way over it goes to pieces again? A. It is plated out. If you will let me, I will show you how lead chloride solution and copper chloride solution—

The Court (interposing): I want to see after it leaves as free lead and winds up as free lead, as I understand it, it gets a ride across there with some new neighbors. A. Yes.

The Court: Whether it comes out in a parachute or what, I don't know, but after it takes that trip across it gets out as free lead again. A. Well, now, the first thing I want to explain is what happens when you take a piece of ordinary steel and immerse it into hydrochloric acid which contains lead chloride and some copper chloride. We will assume the lead is the material that is going to do the inhibiting. We have shown in various tests it does a little. I will explain how it does it. There is no free lead in this

system whatsoever—it is just taking a piece of metal, steel, immersing it into a solution of hydrochloric acid that contains the lead chloride in solution. I haven't taken up the lead chloride.

The Court: You have just got lead chloride then? A. We have just lead chloride without any lead sheet at all (indicating). If we consider a piece of steel, in the structure of steel there are crystals of various materials present in the steel that crystallize out, and some of those crystals, the major part of them, are crystallizing pure iron or ferride (indicating on the board). Now, let us assume that we have some ferride crystals here, covering most of the surface, but in steel we have other elements than iron; we have carbon; we have sulphur and phosphorus, and those elements combine with iron to form compounds, and those compounds, when the steel solidifies, they crystallize out and form small particles and crystallize around through the surface.

The Court: Some of them are better for some uses, for certain uses, and some worse for certain uses. A. That is correct. So we will consider that these are iron crystals, and let us consider here—I want to draw it large enough so that you can see it—this is a particle of Fe_3C, or cementite, which is the common form in which carbon occurs in steel. So we have here a particle of cementite in the surface of steel.

The Court : I am to think of those as separate molecules? A. They are not separate molecules. They are separate crystals. You can see them under the microscope. They aren't down to the molecules. They are large enough to be seen under the microscope.

The Court: But made up of many molecules? A. Made up of many molecules.

The Court: They are not all alike? A. They are not all alike. In the case of the Fe_3C, there is different, very small crystals of Fe_3C, and the ferrite is considerably larger in size. The ferrite crystals, being in larger amount, why, they crystallize and tend to form larger crystals. The amount of iron carbide is usually less than 1 per cent, and,

therefore, there is such a small amount coming out the crystals are usually finer, and this particular arrangement, the iron crystal in electrical contact in the body of the steel with another material, Fe_3C, two different materials in electrical contact, that is, two crystals which are touching each other electrically in the piece of steel—we are looking through a cross-section of the piece of steel—outside here, if we put on the surface some water solution, and let's put hydrochloric acid, in the solution, this is what occurs. First the iron has a definite potential or tendency to go into solution, which we call its solution tension. It has a very strong tendency to go into solution. The iron carbide very little. We usually measure those differences in tendency to dissolve by the voltage, which is the electrical pressure tending to go into solution. This iron has a very great tendency to go into solution. This material has substantially none, practically zero. It is quite inert.

The iron is a material that tends to dissolve. Now, here we have, if we measure the voltage between the iron and iron carbide, we find it is in the order of one to three-tenths of a volt, which is a fair voltage. The difference in potential right in two adjacent crystals here, we have a water solution on top in contact with these two dissimilar particles.

The Court: I thought we had hydrochloric acid. A. That is a water solution, hydrochloric. We have three-tenths of a volt difference. This force is there tending to throw the iron out into solution.

The Court: Yes. A. That is the driving force for this cell. And we have a complete electro-chemical cell, we have a cell with an electrolyte, two different electrodes at different potentials, and we have the external circuit with the solution, the metallic circuit closed, just as though we had this electrode here or here.

The Court: For all we thought of that as a piece of steel, that we put in, you get that going on within the family. A. It is right inside the body of steel. It is just as though we had a piece of iron here in a galvanic cell, like

a dry cell, and a piece of iron carbide here, and we have .3 volts difference between the two, and then we took and put a bar of steel or something across outside here and dip this in hydrochloric acid. It is exactly the same action.

The Court: In other words, it is the same as if there were two different metals. A. Two different electrodes.

The Court: Like what goes on between copper and iron, or zinc and copper, or lead and iron. A. Yes.

The Court: So as between this kind of iron and this kind of iron, you get a— A. (interposing): That is correct. They are the same action entirely.

The Court: I follow you. A. All right. Now, if we can get this picture—

The Court (interposing): How does that compare with between lead and iron? I mean in strength? A. Well, the lead and iron that we got between this tubing and the tank was on the order of one to two hundredths of a volt, and here we have three-tenths right in the metal itself, in point to point contact with the metal. In other words, the point I want to make is to impress one or two hundredths of a volt on a three or four thousand foot pipe line, you can't do it and hope to do much protecting of this end, while in the iron itself there are differences of potential amounting to a tenth of a volt or more. This iron has this force which is tending to throw iron into solution. And when you take an atom of iron and throw it into solution, iron will not dissolve in water solutions, but it will form a ferrous ion, and the ferrous ions will stay in solution if you have got a negative ion associated with it, and when you do that you produce two negative charges or electrons. And so this force throws an iron ion into solution. The cell is going to act now. The action of the cell is throwing an iron ion into solution. The two electrons go through this circuit. The concentration of electrons in this electrode now is high and the electrons flow through the circuit.

The flow of electricity through a metal conductor is a flow of electrons. It is not a flow of actual particles, like iron atoms. That only takes place in water solutions, where

they can move. But in an electric, solid electric conductor, why, it is an electron flow.

The Court: One of them joggling the other. A. Yes. And this electron pressure on this side is considerable. It is three-tenths of a volt difference in electron pressure. Those electrons come over and try to charge this electrode up to the same potentials that they have, which is three-tenths of a volt.

Now, in the solution we have hydrogen ions and chlorine ions, and we have a considerable number of them. And in the solution these ions are moving. We have a passage of current through the external circuit and we are going to have a flow of negatively charged ions in this direction and positively charged ions in that direction. The passage of current through an electrolytic conductor causes a motion of positively charged ions in one direction and a negatively charged in the opposite.

These iron ions go into solution. Then two chlorine ions, which are associated with the hydrochloric acid, two of those come over and simply—they don't hook up solidly with them, but they are in a loose sort of kinetic state of equilibrium with the chlorine ions and iron ion. That is ferrous chloride in solution. That is ionized ferrous ions and chlorine ions.

These two hydrogen ions, which are going in the direction of flow of the positive electricity come here and plate out hydrogen on this electrode, and so we have a film of hydrogen produced on this electrode, and the electrode is converted, now, from an iron, iron carbide electrode, you see, these hydrogens come here, deposit, because the electrons, the two electrons we got off the iron atom came over to this here, and the two electrons add onto the two hydrogen ions, and we have hydrogen deposited. Now we have a hydrogen electrode and an iron electrode.

The Court: What are the hydrogens doing on that iron over there? A. The hydrogen changes this from an iron carbide electrode to a hydrogen electrode. It has a different potential now. The iron carbide had practically no potential, but the hydrogen has some potential.

The Court: Is that detrimental. A. That is detrimental only to this degree—

The Court: Does it affect that iron, now? A. It is not detrimental, but whenever this action occurs that I have described of iron going into solution from the metallic state to the ionic state, you have the corrosion, you have converted some of the steel. Just the hydrogen plates out over there.

The Court: Isn't that protection? A. That is a protection, because the voltage of the cell now drops from about three-tenths of a volt to about one-tenth of a volt.

The Court: That is what I was thinking. It would tend to immunize that. A. Polarize it.

The Court: Cure itself of this danger. A. Yes, it does. It does tend to do that. But in this particular solution it is not sufficient, the hydrogen will not build up a sufficient back voltage or tendency to go into solution to repress the flow of current in this cell to stop corrosion. The corrosion will continue. If you put a piece of steel in hydrochloric acid you will get bubbles evolved, and the action continues and it continues in this particular manner.

The Court: I would think it would be in a receding, a decreasing degree? A. No. On this particular surface, the hydrogen plates out, and then when it gets a thick enough film, bubbles form, and the bubbles escape and uncover the surface of the iron carbide again, and so the action continues.

The Court: There isn't anything there for the hydrogen to hook up with at all? A. No, it is simply hydrogen gas. It has been converted from the ionic state in solution over to hydrogen gas, such as they use for filling balloons, and so forth; and that gas forms a thin film on the surface and then bubbles away. But the voltage of the steel is dropped somewhat from three-tenths maybe down to one or two-tenths of a volt, due to this hydrogen. Hydrogen puts resistance in steel, and that resistance tends to reduce the amount of current that is flowing in the circuit. Now, we are going to put some lead chloride in the solution, and

when we do that the concentration of lead chloride is very low, I mean—

The Court: Do they add that pure iron, every particle of it—if you added all that in, the hydrochloric would not act on it? A. That is substantially true. If you could get a piece of pure iron that had every crystal and every particle of it in exactly the same state, so that there would be no difference in potential—but that is a practical impossibility—they have tried to make pure iron, and they find that the difference in the annealing of one part to another creates a difference in potential. In other words, if you have pure iron with no impurities, if you strike a piece of pure iron with a hammer, the voltage or potential of that struck part is greater than the annealed or—greater than the annealed part that has not been struck at all; and, therefore, you create a potential in C. P. iron, and it is impossible to create a formula without some differences in potential, either due to differences in annealing, due to differences in composition, or the working of the metal, and so you get this difference in potential which starts with this galvanic action.

Well, now, if we put into here some lead salt, like lead chloride, the chloride ions that we would have migrate toward the iron, just as the chloride that was associated in the hydrochloric acid. The lead ions would come over in the direction of flow of the positive ions and try to discharge along with this hydrogen.

The lead ion concentration is so small we get a partial coating out of lead on this surface, and so we get there with the hydrogen and we get a few spots of lead plating out, but that lead has a very important effect upon the action of the cell, although it is present in small amounts. That lead holds the hydrogen film on the surface. It holds the film on the surface to a greater degree than if the lead were not present. The copper does the same thing.

The Court: The lead does not then, if I can use my magnifying glass, it doesn't actually hit the iron and coat the iron, but as I understand it, there is a sandwich and

hydrogen is next to it? The hydrogen is next to the iron? A. Here is a particle of lead plated out, and here is another one, and so on, maybe a molecule or two, quite an imperfect coating. Then the hydrogen fills in like this, and those little points hold the hydrogen film on to the surface. Your solution is out here.

The Court: I thought the hydrogen was there before the lead got there? A. No, in this case—

The Court: Over here I didn't have any lead? A. You didn't have any lead in the first case.

The Court: But we had a coating of hydrogen? A. Yes. When you have lead present, they both start coming out together and you get an imperfect plating. There are a number of metals that have that particular action.

The Court: As I understand it, the lead chloride is out in solution? A. It is in solution in the acid.

The Court: And these particles of iron start from a point and find their way around and pick the iron up on a little bit of a coastal trip around to the different kind of iron? A. Yes.

The Court: And in that course they pick up the lead chlorine? A. The chlorine from the lead chloride and the chlorine from the hydrochloric acid. You have ions from both. You have both ions.

The Court: I don't understand everything, chloride and chlorine? A. Chlorine is the element, chlorine. That is the greenish gas. Chlorine is the element and it is not chloride. Chloride ion, Cl is an atom of chlorine.

The Court: Chloride is hitched with any other metal. A. A negative electrode, and to get chloride, the chlorine particle, if we take a chlorine atom, it is electrically neutral. A chlorine atom is electrically neutral, and if we hook two of them together we get the chlorine molecule, which is ordinary chlorine gas that is used for treating water and sterilizing and so forth. But if we hook this chlorine up with a metal then we form chloride, and that ion is different than the chlorine here because it is electrically charged, and the chloride can exist in solution in very high concentration.

You can't take chlorine gas and put it in water. It won't dissolve. If you electrolyze it it won't migrate because it is not electrically charged, whereas the chloride ion is electrically charged.

Well, now when we put hydrochloric acid on here we have hydrogen coming out in the impurity, iron dissolving here (indicating) the chloride ions hooked up with the hydrogen ions to make hydrochloric acid. That is hooked up into the solution and you produce ferrous chloride. When you produce ferrous chloride in a piece of iron you have corrosion. So we do everything in this cell. We want to inhibit the action of the cell. We do everything to stop that from functioning when we put inhibitors in. The inhibitors reduce the amount of current flowing into this cell, cut it down and therefore the amount of iron corrosion is reduced because the amount of iron corrosion in this cell is a definite quantity of current for a definite amount of iron.

Putting the lead in, just putting in hydrochloric acid within a few hundredths of a per cent of hydrochloric acid on top of a piece of steel, we get the inhibiting effect with the lead along with the hydrogen. That tends to hold the hydrogen here (indicating) and we put into the cell a tenacious film of gas which has a high resistance and therefore a resistance which reduces the action in the cell. You cut down the current and therefore the corrosion of the iron electrode in this case. So the lead acts in that manner. That is the way which lead and copper act as inhibitors. They form a very imperfect film on the surface of the impurities that tend to hold the hydrogen in place, and that is what is sometimes called polarization and there are other terms used for it. There is a term here of over-voltage, which I have not gone into because I think it is too theoretical.

Mr. Owen: This is a sort of a first lesson, Your Honor. I think we will revert to it later and I want to go to another matter now, with your permission. I am reading from one of defendant's advertisements which was published in March, 1937, and entitled "Howco Method of Protecting Tubing and Casing Against Corrosion While Acid-

izing a Well." This quotation is rather lengthy but I have to get it to the witness in order to get the explanation.

(Whereupon the document above referred to was marked PX-186 by the reporter.)

Mr. Owen: Beginning on page 2 under this heading again "Howco Method of Protecting Tubing and Casing Against Corrosion While Acidizing a Well."

"This method consists essentially of using the steel of the tank as one plate of a large battery. The hydrochloric acid in the tank is used as the electrolyte, and installing another plate to form the other electrode of the battery.

"The well known principle of electro chemistry is where corrosion takes place an electric current is produced and conversely where no corrosion takes place no current is produced or if there is no current there is no corrosion. This principle is explained to some extent under the heading of "Passivity," paragraph 3, page 2322, Chemical Engineers' Handbook by John H. Perry, Editor-in-Chief.

"To make this principle easily understood we can refer to the ordinary battery, for example, the dry cell. This battery is made up of two electrodes, one of carbon, and one of zinc with an electrolyte to complete the cell. The manufacturers of such a battery have attempted to make it as efficient as possible, that is, to produce as much current as possible without it becoming polarized. To accomplish this a depolarizer is used. The manufacturers have done this in order to get the maximum possible amount of corrosion which means the maximum possible output of electric current since that is the object of this battery cell.

"If this same cell is constructed without a depolarizer and wires of sufficient size to carry the current are connected from one terminal to the other an electric current will flow. This current would continue to flow as long as corrosion takes place, but would stop very quickly if no depolarizer was used, due to the fact that the positive electrode would become coated with hydrogen, this is called polarization. As soon as the cell became polarized the current would stop flowing and no more corrosion would take place. If an in-

efficient battery is made, polarization will take place immediately. This is the object that is accomplished in the acid tanks. It is done by using a lead plate which has a higher voltage in the natural electrical scale than the iron tank itself. This plate is installed in the tank in such a way that even if a small amount of acid is present, the acid is in contact not only with the tank itself, but also with the lead plate. The lead plate at each end is thoroughly bonded to the tank to make the best possible electrical connection or short circuit. The lead plates in the tank contain over 30 sq. ft. of surface on one side, with both sides considered it is double that amount and this makes a huge battery cell out of the tank when acid is put in it to act as an electrolyte.

"If a tank was so made up and acid placed in it corrosion would immediately start and continue until the tank became completely polarized. This would mean some corrosion to the lead plates and also the tank.

"To save this lead electrode a temporary electrode is placed in the tank and current applied in the proper direction the first time the tank is filled with acid. This is done to complete the polarization in the least possible time, therefore preventing any corrosion that might take place before the tank has had time to become polarized. It is found in laboratory experiments that this voltage applied is not critical and even an excess current flowing will cause electrolysis of the lead, thereby plating the walls of the tank with a very thin coat of lead which only aids in the protection of the tank. After the tank has become thoroughly polarized it no longer needs attention to protect it from corrosion, because even if the tank should become depolarized in spots, with the large size plates a large amount of current would be concentrated at that point and cause very rapid polarization. After the tank has been prepolarized it is filled with acid and taken to the well to be acidized. On arrival at the well a heavy electrical conductor or cable which is well connected to the tank itself is then connected to the tubing or casing to be protected. This is only a means of

making the tubing and casing a part of the electrical system of the tank and should be used at all times whether the well is connected to the tank by pipe or tubing because sometimes flexible joints in the tubing may not make a good electrical connection.

"The voltage of the battery formed by the tank is thirty-five hundredths of a volt, therefore it should have a good conductor and as little resistance as possible in the short circuit so that this low voltage current can readily flow from one point to the other. After the tank is connected electrically to the well head the well becomes a part of this large battery and since the tank is polarized before arriving at the well no current is flowing in the system. After the tubing or casing is made a part of the system by connecting it to the tank the acid is started into the tubing or casing. The flow of current immediately goes to the part that is unprotected and is concentrated there, immediately polarizing it. After the acid flows down the pipe in the well, concentrated polarization takes place very rapidly at the point where the acid first comes in contact with the pipe and continues to at each new portion as the acid comes in contact with it. If we consider the lower end of the tubing in a well and assume that the acid has not yet arrived at this point, wherever the acid has been in contact with the tubing polarization has taken place and as the acid moves down to the bottom end of the tubing the polarization and flow of electrical current is concentrated at this unprotected point. The reason is that the acid having been in contact with the upper part of the tubing or casing, has already polarized that part of it so that no more current can flow to the polarized part and no corrosion can take place at that point. Therefore, the polarization will take place as the electric current flows to the lower end if the acid moves to that point and comes in contact with the tubing. The hydrogen that forms on the lower end or unprotected part of the tubing does so immediately when the acid comes in contact with the tubing at that point. It is not necessary for this hydrogen to travel from the tank down through

the column of acid to the point of contact on the tubing because the hydrochloric acid molecule that is in contact with the iron is immediately broken down by the electric current into hydrogen and chlorine atoms. The hydrochloric acid atoms that are immediately in contact with the iron are broken down into chlorine ions and hydrogen ions, due to the electrical potential imposed on the acid and the hydrogen ions released from the hydrochloric acid molecule cling to the pipe while the chloride ions immediately combine with the adjacent hydrogen ions, setting free other hydrogen ions which in turn combine with the adjacent chlorine, this all taking place immediately as soon as the current starts to flow. Therefore, one hydrogen atom is replaced at the contact point of the tubing and one chlorine atom at the contact point at the lead plate, all at the instant that the current starts to flow, therefore polarization and consequently protection is very rapid and the pipe is protected at all points where it is in contact with the acid. After the acid has passed on into the formation the pipe is still protected, due to its polarization remaining for some little time afterwards. It has been found by laboratory experiments that using a small steel tank, installing lead plates in it and placing hydrochloric acid in it, that the acid could be left for weeks without damaging the tank. That acid taken from this tank was not inhibited because it would immediately start corrosion if iron was placed in it.

"But so long as the lead plates were present and the electrical connection made the battery formed in this manner prevented corrosion from taking place and the acid was not active while these conditions were present."

Mr. Owen, continuing: Doctor, I wish you would state very briefly what you understand this advertisement to mean, and particularly with reference to the statement that the polarization of the truck tank is accomplished from an external source, and that the polarization of the well tubing takes place immediately when the acid comes in contact with it?

Mr. Lyon: If Your Honor please, to avoid any con-

fusion in the record, I would like to object to this term "advertisement." I do not know by what authority counsel states that this is an advertisement.

Mr. Owen: When Mr. Clason's deposition was taken, this advertisement was produced by him, and it was identified in connection with his deposition. Mr. Clason is here.

Mr. Lyon: Is it an advertisement?

Mr. Owen: Here is Mr. Clason. Let us ask him.

Mr. Owen: All I want from Mr. Clason is whether this circular or folder was distributed broadly throughout the trade.

Mr. Clason: It was distributed to our men, who I do not doubt gave it to some of our customers.

Mr. Owen: You sent quantities of these pamphlets to each of your stations, did you not?

Mr. Clason: Yes.

Mr. Owen: And they were intended to be handed out to your customers, or prospective customers?

Mr. Clason: Yes.

Mr. Lyon: Who was it written by?

Mr. Owen: I don't think it is of any importance. Well, who did write it?

Mr. Clason: Mr. A. D. Stoddard, vice-president in charge of our shops and plant there.

Mr. Owen: It expresses his views, as you understand them?

Mr. Clason: As an engineer.

The Court: What is that?

Mr. Clason: As an electrical engineer.

The Court: He is an electrical engineer?

Mr. Clason: Yes.

A. (Dr Prutton): The article which you have just read very definitely claims that the purpose of the lead plate in the truck tank is to inhibit the corrosion of the oil well tubing in the well, and claims that that is accomplished. The claim is also made that they polarize the truck tank with an external method other than just the lead sheet alone before placing it in service, and that the tubing is protected also by this electrolytic protection method.

Mr. Owen: Well, now, what is the fact, as you understand it, regarding the protection which is provided against corrosion in the oil well tubing due to the presence of the lead plates in the truck tanks of the defendant company? A. As a result of the large scale tests that I have made, which clearly show that the lead plate exerts no electrical protection effect, the reduction in corrosiveness which they apparently obtain in service in the tubing is due to the inhibitors contained in the acid, and not to any electrical effect. That is my conclusion, both from theoretical grounds and from the results of the many tests that we have run.

Q. And what does the presence of the lead plates in the tank have to do with the presence of the inhibitors in the acid which goes down the well tubing? A. The lead plate supplies most of the lead chloride content of the acid just before it goes down the tubing, and it supplies probably a majority of the copper content of the acid, the two, the two metals which are the inhibitors in the acid entering the well.

Q. Now, when copper chloride and lead chloride are in solution in hydrochloric acid, does it make any difference in the inhibiting effect whether they are added to the acid in the form of copper or lead chloride or are produced in the acid due to the presence of lead plates or other materials from which those chlorides may be produced? A. There would be absolutely no difference. The materials would be identically the same. If you take lead chloride and dissolve it in acid you get a solution. If you take a piece of lead and dissolve it in hydrochloric acid you get lead chloride, and if you simply dilute that with more acid you have the same thing which you would get by taking either solid lead chloride and dissolving it in the acid, or first dissolved the lead to make lead chloride and then putting it in the acid, and the same thing would follow with copper.

The Court: I think I would like to have the doctor point out the particular things in there with which he disagrees, if he disagrees with that article. I think I get it from what he said.

Q. Will you do that, Doctor? A. That is rather a long order. The explanation of the electro-chemical changes and how they take place in there are very unorthodox, and are written evidently by a man who is an electrical man, as they state, but not an electro-chemist that really knows what happens in a solution, and it is not hitched together in each little detail. The thing is quite garbled, and the whole story that it tells is completely incorrect, in my opinion.

The Court: I will accept that as the answer to my question without pressing it further. A. His explanation of breaking up of hydrochloric acid is not thorough. And the vague interpretation I would make of it is it is not even correct.

Mr. Owen: Doctor, referring to your large scale tests, in some of which you stated that you added lead chloride, copper chloride and iron chloride to hydrochloric acid in a steel, or in a stoneware crock, and in others of which you placed hydrochloric acid in a steel tank made to simulate that of the defendant company, and in those tests lead chloride and copper chloride and iron chloride were produced, did you find in those tests any different effect in those where you added the chlorides and in those where you produced them through the presence of the lead plate and the contact with the acid and so forth? A. We got substantially the same inhibiting effect whether the metal was placed in the acid dissolving the salts or whether we put the acid into the tank and let it dissolve the lead plate in the tank, producing the salts in the solution.

Q. Well, in this advertising literature which I read, I repeat this statement:

(Reading): "It has been found by laboratory experiments that using a small steel tank, installing lead plates in it and placing hydrochloric acid in it, that the acid could be left for weeks without damaging the tank. That acid taken from this tank was not inhibited because it would immediately start corrosion if iron was placed in it."

How does that statement agree with your experiments? A. I think that there is a slight element of truth in that

statement. In other words, if you had acid in this steel tank with the lead plate on the bottom, the lead dissolves, the copper dissolves, to make an inhibited solution, and you get some small amount of electrolytic protection on that tank, because the lead is so close to the iron there, just adjacent to it. But if you take some of that acid out and put it on iron, it would act on the iron. Any acid will act on iron, even when it is inhibited, as well as we can inhibit. There is always some action. And, therefore, to say that it would attack iron is perfectly correct, but it would not attack iron anywhere nearly as much as commercial hydrochloric acid would attack it. The acid is definitely inhibited, and that is incorrect in that statement that you read to me. It states that the acid is not inhibited, and I state that it is inhibited.

Q. Have you made any tests to determine the amount of protection against corrosion that results from the mercaptans found in Michigan crude oil? A. We have made some tests to study the effect of Michigan crude oil upon attack of acid upon oil well tubing, and the oil which we used was obtained from the Zahn well, which is one of the wells in suit, I believe, or in question here. I have the results of those tests.

Q. Will you explain those tests and the results? A. There were three different sets of test conditions. These tests were run upon the one-inch lengths of oil well tubing that I described before, that we used in our laboratory scale inhibition tests. We took chemically pure hydrochloric acid, and diluted it to 15 per cent, and measured the rate of attack of that 15 per cent C. P. hydrochloric upon the lengths of oil well tubing. We then took some 15 per cent C. P. hydrochloric acid, and added to it lead chloride alone in the amount of 340 parts per million of lead, and ran the corrosiveness of that acid upon the oil well tubing. We then took C. P. hydrochloric acid 15 per cent, and added to it 340 parts of lead, that is lead chloride, 380 parts per million of iron, in the form of ferrous chloride, and 3.8 parts per million of copper, in the form of cuprous chloride. So

we had three different acids that we used, the C. P. diluted, the C. P. diluted plus lead, and the C. P. diluted with iron, lead and copper in it.

Now, the first test was made without any oil being present. They were made without any oil present. And, of course, we took the—we measured the decrease in rate of attack or the percentage of inhibition of the acids, and we took the fifteen per cent C. P. as the reference point. There was a one hundred per cent rate of attack or a zero per cent inhibition. That is the reference point. The addition of 380 parts per million of lead in the form of lead chloride reduced the corrosiveness by 9.3 per cent. When the copper, iron and lead were incorporated in the acid, the reduction in corrosiveness was 62.1 per cent. That is the first series of tests run without oil.

The second series were run with oil in the test. The one inch length of oil well tubing was dipped into the crude old for several minutes, removed, and allowed to drain for several minutes, and then the oil-coated ring was placed into the test bottle containing the acid. The fifteen per cent C. P. hydrochloric acid, the inhibiting effect of this oil film on that particular sample reduced the corrosiveness by 12.1 per cent. In other words, this oil film on the pipe reduced the rate of corrosion by a little over twelve per cent. The acid that contained the lead chloride, when we placed the oil soaked length of oil well tubing into it, it reduced the corrosiveness by 21.9 per cent.

Q. As compared with what without the oil? A. Without the oil it was 9.3. In other words, there was about twelve per cent effect of the oil added onto the lead. In other words, the oil inhibition is additive to the metal inhibition. The lead chloride conferred inhibition and then the oil conferred additional inhibition on top of that.

The third test or the third acid was the chemically pure acid which contained, as I said, iron, copper and lead chlorides, and the reduction in corrosiveness was 70.5 per cent. The oil contributed to the inhibiting effect of the three metals present by 8.4 per cent. Now, the third set of con-

ditions was to take the acid which was to be used in the test and add to it two per cent of its volume of crude oil, shake the oil up with the acid, and then immerse the clean steel specimen into that oil emulsion in the acid. The first test using that method, using C. P. fifteen per cent hydrochloric acid, the reduction in corrosiveness was 20.4 per cent. Applying the oil in that manner reduced the corrosiveness of the acid 20.4 per cent. When the acid containing the lead chloride was used, the reduction in corrosiveness was 28.2 per cent. Now, if you will recall, the lead chloride and the acid without any oil present at all was about 9 per cent reduced. With the oil present, and the lead chloride, it is 28 per cent. The oil alone gave 20 per cent. And, therefore, the two are substantially additive. The inhibiting effect of the oil adds on top of the inhibiting effect of the metal.

In going over to the acid which contained all three metals present, and employing this method of shaking the oil up with the acid before immersing the sample, the reduction in corrosiveness was 75.7 per cent. Again showing that the oil contributes additional inhibiting properties to the inhibiting properties of the metals that are present in the acid.

Q. Were those tests made with agitation? A. These tests were made without agitation. They were made in the standard manner that I described previously under our laboratory test conditions.

Q. Doctor, referring to the defendant's tanks, will you state whether the formation of copper, lead and iron chlorides is a continuing process so long as the hydrochloric acid is contained in the tanks, and even after they have been initially polarized? A. The process continues, as shown by the fact that the acid in the polarized tank that we used in our tests picked up iron, lead and copper, and we have test data that shows the concentrations that were picked up at the end of one hour, and two hours, and there is a regular progression in the amount of metals picked up, and iron is one, lead and copper the others. It is not a regular thing in the sense of a nice, smooth curve, but it is in the sense that

you are comparing between different runs, and I am comparing in one run. We dipped out of this tank, at the end of one hour we took out acid, and we had some at the beginning; and at the end of two hours, and there was a constant increase in the copper content and in the lead content and in the iron content over that six hour agitation period.

The Court: There was not any drop at all? A. No, it was just a constant upward curve, showing how the regular solution of metals went into the acid.

Q. If the acid in the defendant's truck tanks did not contain these inhibitors, would anything result from the cable connection between the tank and the well tubing? A. If we had an uninhibited acid, that is, acid which had these metals in it, and ran it into the well tubing, and we had this lead sheet in the tank—would it protect? It is my opinion that it would not protect.

Q. The question was a little more specific than that, and that is, that if the acid in the defendant's truck tanks did not contain these inhibitors, even disregarding the presence of the lead plates for the moment, if the acid did not contain inhibitors when it leaves the tank, would this cable hook-up have any effect one way or the other? A. No, it would not.

Q. And if the acid does contain inhibitors when it leaves the tank, does the cable hook-up have any effect one way or the other? A. In my opinion it has no effect.

The Court: The whole answer to that in your theory is that it has iron enough to work on, without some more so far away. When you get all through with it that is about what it is, isn't it? A. That is correct.

Mr. Owen: And that whatever protection there is in the well tubing is due to the presence of these inhibiting agents in the acid as it passes through the tubing? A. Yes.

The Court: As I understand you, Doctor, that lead does do some good to the tank, or I mean to whatever—I leave out the word "inhibited"—from preventing the acid from eating the iron of the tank? A. I think it does some slight—has some slight benefit there, possibly reducing the rate of attack some twenty per cent.

The Court: When it gets over into the tubing it is so far away it doesn't? A. Yes. In the tank acid, as you recall, the acid leaving that tank is, according to our figures, 75 per cent inhibited due to the chemical inhibitors. Well, with 20 per cent electrolytic protection due to the lead plate and 75 per cent due to the metals in solution, the tanks undoubtedly last quite a length of time.

The Court: How much of that 75 per cent inhibition do you attribute, or do you attribute it at all, to the action of the acid on the lead during the time the acid is in the transportation tank? A. It comes from the lead sheet and possibly some small amount of copper might come from this tank.

The Court: You don't give any of it to the—any appreciable amount, what it does to the tank before? A. I think that lead that is on the side of it, and copper that they take and plate from this lead sheet in the bottom in their polarizing operation, and plate it on the side, partially plate up, I think some of that dissolves too.

The Court: How much will that do the year after next? A. I think it would be all gone in a year. I think it would be all gone in six months.

The Court: If they are right in their contention that is only done once during the life of that tank why, then, during most of the tank life you understand it is negligible? A. Yes, and that the protection, the polarization is not a major factor, and the chemical inhibition of the metals dissolved from the lead plate then is the major factor in protecting it and then some help is obtained by means of the electrolytic protection of the lead sheet, coupled with the iron. I would think they would get 40 per cent inhibition and possibly something like that with their 20 per cent electrolytic, and maybe 70 per cent from the chemical inhibition.

Mr. Owen: And the 70 per cent could be obtained by dropping in the lead chloride and copper chloride and iron chloride in the absence of the lead plate in the tank? A. That is correct. The result would be the same whether you added the lead chloride or let the lead plate dissolve; if you

got the same final concentrations you get the same inhibition.

The Court: But that isn't inhibited as much as the copper and the lead. A. That is right.

Mr. Lyon: I would like to understand the witness' testimony on that point. Is he saying that if we just hung the copper, the lead plate in the tank, in the acid, and didn't connect it to the bottom of the steel, or the wall, we would get the same protection for the tank? A. No, I did not say that. I said you would get, by electrically connecting it, you get additive effect. The amount of it I don't know, but I don't believe it is over a half of the effect.

Mr. Lyon: Suppose we just put raw commercial acid in our tanks, draw them out, but had this same lead plate suspended in the middle of the acid, not in contact with the walls of the tank. Would your testimony be that we would get the same protection? A. Well, I don't think in that case you would get the same protection.

The Court: No.

Mr. Lyon: Would you have the same amount of lead dissolve in the acid in the same length of time? A. I have explained you get some electrolytic protection.

Mr. Lyon: I am not asking you that. Would you have the same amount of lead dissolved in the acid in the same length of time? A. If you didn't have it connected?

Mr. Lyon: Yes; if you did not have the lead in contact with the tank itself? A. I think you would get somewhat less lead dissolved.

Mr. Lyon: How much less? A. I don't know. I don't think it would be over one-third less.

The Court: As I understand the theory, your reason for that answer is it would have farther to carry the lead to get to the iron? A. Well, no. The reason that I would give for that, if you just put the lead plate in the acid without making any connections to the wall of the tank, you wouldn't have a complete electrical circuit, and that the lead that would dissolve would have to dissolve by chemical attack on the lead plate.

The Court: You would have two connections between the iron and the lead, but either route would have to be through the acid. A. Yes.

The Court: You would have no direct metal to metal contact. A. No.

The Court: But you would have two routes. A. Through acid. And that is not a complete electrolytic cell, and the fact that I have said you get electrolytic protection indicates that there is current flowing through your cell when you have the lead plate in contact with the bottom, and that current flowing does dissolve more lead. So you would get more lead in solution with that cell in contact than you would without it being in contact.

The Court: In other words, you think one copper wire connected from the lead to the steel somewhere would do some good? A. Yes. It would do some good on this 20 or 30 per cent inhibition as I have admitted in my opinion, the electrolytic protection does help out in the steel tank to some degree.

Mr. Owen: Have you made any tests with a view to determining the effect of pressure on the action of the inhibited hydrochloric acid? A. We have made a series of tests on a laboratory scale to determine the effect of pressure upon the inhibition of various materials when added to hydrochloric acid solutions. The tests were run using prepared strips of strap iron that were immersed in a two-inch diameter glass test tube containing the acid, that glass test tube was placed inside of a heavy-walled alloy steel bomb and the pressure of one thousand pounds per square inch of nitrogen gas, which is an inert gas, was applied above the sample. And the loss in weight of the samples was determined under those conditions. We also ran a loss in weight of the strap iron in the acid in the two-inch test tube when exposed to the air, or open to the air, at atmospheric pressure, the same temperature and length of time test.

The general conclusion, and there is no major difference, is that the different types of inhibitors, with them you get the same relative reduction in corrosiveness rate at high

pressures as you do at atmospheric pressure. It is the same percentage reduction in corrosiveness. However, the actual corrosiveness of the acids is somewhat reduced.

In other words, same thing, C. P. hydrochloric acid 15 per cent, if that would lose one gram of iron during the test, at atmospheric pressure, under 1000 pounds pressure, why, that C. P. 15 per cent acid would dissolve maybe seven-tenths of a gram. But when you added inhibitor to the 15 per cent hydrochloric acid, you would get a similar reduction in rate of attack with the inhibited acid. So that the percentage reduction is substantially the same. If you want the figures I can give you a table of figures, but, if not, the general conclusion is simply that the rate of attack of the acid is reduced by pressure, whether the acid is inhibited, or not, but the percentage reduction in corrosiveness, the percentage inhibition remains substantially the same.

Q. You testified, Doctor, that 9.3 pounds of iron would be dissolved in one hour of contact between raw 15 per cent hydrochloric acid, in 1000 feet of 2-inch oil well pipe—at least that is as I understood your testimony. A. Yes.

Q. Can you state how much loss in strength to the acid contained in that 1000 feet of pipe would take place in dissolving 9.3 pounds of iron? A. The amount of acid that would be consumed in dissolving 9.3 pounds of iron would be 73/56ths of 9.3 or 1.3 times 9.3, which is 12.1 pounds of HCl would be consumed.

Q. How much would that reduce the strength of the hydrochloric acid, assuming that it was 15 per cent when the reaction began? A. Now you are assuming we just fill this tube with the acid and leave it for an hour. I will have to calculate the volume of that 2-inch tube to figure the amount of acid that it would contain.

Q. Well, Doctor, will you compute that and give us the answer? A. You want to know if I filled this 1000-foot length of 2″ tubing with 15% acid and let it stand for one hour, what reduction in strength would occur. I will compute it later. I prefer to.

Q. When you are making that computation, I wish you

would also apply your same calculations to seven-hour contact between the acid and the well pipe, the tubing being 3000 feet long and 2½" in diameter. A. I have the figures for 7.1 hours' contact, 3300 feet long and 2.66" in diameter. In this 7.1 hours of contact, 3300 feet length of tubing, and the inside diameter of 2.66", 273 pounds of iron would have been dissolved, 355 pounds of HCl consumed, or 265 gallons of 15% HCl would have been destroyed. The 265 gallons of 15% HCl would have been destroyed.

Q. And can you tell how many gallons of HCl would have been contained in that 3000 feet of pipe? A. I don't have that figure but if you ran through 1000 gallons you would get out 735 gallons of effective acid out of the bottom. If you ran through 500, 235 gallons of undestroyed acid out the bottom, substantially.

Q. That is, if it was raw uninhibited acid. A. Yes, attacking at the rate of 9.3 pounds, 2" pipe, 1000 feet long.

Q. And that rate of 9.3 pounds per hour in a thousand feet of 2" pipe is based upon the results of which of your tests? A. Of my blank runs using the diluted commercial acid without inhibitors.

Q. And those are your runs, 1, 1AA, 2A and 2C? A. That is correct.

Q. Tables I, II, III and IV? A. That is correct.

Q. Have you a chart showing the effect on the rate of corrosion of 15% commercial hydrochloric acid, both the raw acid and inhibited acid, based upon your runs? A. I have such chart. (Chart is produced.)

(The chart was offered and admitted as PX-187.)

Q. Will you please explain that chart, doctor? A. In this chart the upper line going across the chart indicates the corrosiveness of the 15% commercial hydrochloric acid without inhibitors, as measured in our large scale tests. The length of that line (indicating) indicates 100% corrosiveness, and referring to that acid as being 100% corrosive.

The amount of corrosion has been calculated for this

chart to be in these blank runs, or the runs made with the commercial hydrochloric acid, 485 grams of iron; that was the average that was dissolved from the oil well tubing by 100 gallons of the 15 per cent acid that was run through the tubing. That is taken as the standard of corrosiveness.

Now, when we run—when we add to the acid various amounts of copper, lead and iron, in the form of chlorides, we get a reduction in corrosiveness, and the amount of reduction in corrosiveness, the percentage reduction in corrosiveness in run 1-B, which we ran, where we took the 15 per cent commercial acid in the stoneware crock, and added the metallic chlorides to it, agitated them, and then ran directly from that stoneware crock to the piping system, there was 75.6 per cent reduction in corrosiveness, as compared with the commercial acid, or 75.6 per cent inhibition compared to commercial acid.

In run 2-B, which is shown in this third line, in which the copper content was 3.07 parts per million; lead, 316 parts per million, and iron 2315 parts per million, the reduction of corrosiveness was 66½ per cent.

In run 2-D, with 3.71 parts per million of copper, 455 parts per million of lead, and 418 parts per million of iron, the reduction in corrosiveness was 77.6 per cent.

In run 2-E, shown in the last column, with 3.8 parts per million of copper, 340 parts per million of lead, and 382 parts per million of iron, there was 89.1 per cent reduction in corrosiveness, as compared with the commercial acid used.

Q. Have you also a chart showing similar information in connection with your runs using the simulated Menaul tank or Halliburton tank? A. I have such a chart. This chart shows the reduction in corrosiveness that was obtained in these tanks employing the simulated Menaul type tank, and the first line of the chart, the first heavy black line indicates the corrosiveness of 15 per cent commercial hydrochloric acid when run through the piping system directly from the stoneware crock without the Menaul tank.

That is our reference point in our comparison of cor-

rosiveness. In this the corrosive effect of the commercial acid without any lead plates or anything in it is shown, and that is the rate of attack and it is 485 grams per 100 gallons of acid passed through the system, which is identical with the reference figures in the first chart.

(The chart was offered and admitted as PX-188.)

Q. That was the same basis as in PX-187, the previous chart? A. That is correct. Now, in the second line the figures for run 1-N are given.

Q. Now explain again what that run 1-N was? A. Run 1-N was a run made with the Menaul type tank in which the acid was 15 per cent commercial hydrochloric, which was run from the stoneware crock into the Menaul tank, agitated for about six hours and then run from that tank through the tubing system and the tank and the tubing system were connected together with a copper wire in order to practice the Menaul process of inhibiting the corrosion of oil well tubing. The conscript "M" in these runs indicates the ones that practice the Menaul process, and the number 1 indicates simply that we used the No. 1 series of tubing. And in this result we got 66.6 per cent reduction in corrosiveness, this particular test, with the cable connecting the tank and the tube. In the third line run 1-M is given, and in that the wire was disconnected, but the Menaul tank was used, same condition, other than disconnecting our wire. 68.8 per cent reduction in corrosiveness was obtained.

In run 2-M, that is, the fourth line, heavy black line, horizontal black line, run 2-M is given, the figures for it. That was the Menaul tank using the steel tank, the lead sheet in it, the tubing system, the electric cable between the tube connecting them together, as described in the Menaul patent, and in that test the reduction in corrosiveness was 70.8 per cent.

In the last horizontal line, run 2-N is given. 2-N is a run in which the cable was disconnected, the Menaul tank was used, and the number 2 signifies that Series 2 tubing was used, an entirely different set of tubing, and the reduction in corrosiveness in that test was 78.5 per cent.

So you can compare 1-M and 1-N, with the wire connected, 66.6, and with the wire disconnected 63.8. They are about the same. 2-M and 2-N can be compared, 70.8 with the wire connected and 78.5 with it disconnected. And if you average them up, why it shows that the wire does a little good and the other shows it does a little harm, but substantially the figures are within the accuracy claimed for these tests, and there is no appreciable effect of that copper wire, which is essential in practicing the Menaul process.

The Court: Have you ever run more than those two tests? I am wondering whether there was just the one. A. Of course, there are four tests there.

The Court: About half the time more and half the time less. In other words, it indicates it makes no difference. A. These were the only tests that we have run on the Menaul process. We have some other tests that were run but were not reported, and I think we are going to report those later on. That for some reason or other there was a deviation, for example, we ran one test in which we tried to run the acid through the Menaul tank so fast it could not be inhibited, and run it in and immediately run it out, but we found even in that case we got 50 per cent inhibition. In other words, we wanted to test its electrical effect with the whole set up connected, and we could not run it through fast enough to avoid contamination of the acid. And these are the tests that we have run.

Q. Now, Doctor, have you also a chart which shows the results of your tests, your laboratory tests, using C. P. hydrochloric acid? A. We have such a chart.

(The chart was offered and admitted as PX-189.)

A. In this chart, the reduction in corrosiveness was obtained by the addition of small amounts of copper, lead and iron to chemically pure hydrochloric acid, and the results are shown. In the first line, horizontal line, is shown the corrosiveness of hydrochloric acid, which is taken as one hundred per cent. Fifteen per cent hydrochloric acid is taken as one hundred per cent. Then, in the second line,

the results obtained with this fifteen per cent C. P. hydrochloric was taken, and 2.14 parts per million of copper were added, 242 parts per million of lead and 473 parts per million of iron were added in the form of chlorides. And when that solution was run in the laboratory tests the reduction in corrosiveness was 59.7 per cent.

In the third test, the third horizontal line, to the fifteen per cent hydrochloric, C. P. hydrochloric, was added the same amounts of lead and iron as we had in Test 2, but the copper was stepped up from 2.14 parts per million to 3.72 parts per million, and the reduction in corrosiveness, by increasing the copper from 2.14 to 3.72 parts per million, the reduction in corrosiveness which we obtained was 70 per cent on that sample. In other words, about 10.3 additional inhibition by the doubling of the copper content, or almost doubling.

Test 4 is shown in the fourth horizontal line. To the fifteen per cent C. P. hydrochloric acid was added 1.86 parts per million of copper, 510 parts per million of lead, and 473 parts per million of iron. The 1.86 is supposed to duplicate the copper content of Test 2. In other words, it is substantially two parts per million. The iron remains the same as it was in the first two tests, but the lead is increased to about double the content it had before. And the corrosiveness of that sample showed the acid was reduced 62.7 per cent. The inhibition was 62.7 per cent.

In other words, three per cent increase over that of the mixture in Test 2. Test 2 had two parts of copper and 240 of lead and 473 of iron. Keeping the copper and also the iron—keeping the copper at 2 and the iron at 473, and jumping the lead up to about 500, gave three per cent additional inhibition in this mixture.

In Test 5, as reported in the fifth column, or, in the fifth horizontal space, or line, 15 per cent C. P. hydrochloric acid, 4.18 parts per million of copper were added; 510 parts per million of lead; and 473 parts per million of iron.

The lead and the iron contents are identical with those reported in the acid used in Test 4. The copper, however, is about doubled.

The reduction in corrosiveness obtained with that acid is 71.4 per cent. The doubling of the copper content again reduces the corrosiveness about 8 or 9 per cent.

In Test No. 6, which is shown in the sixth horizontal line, running about two parts per million of copper, 1.86 to be exact; 204 parts per million of lead; and increasing the iron content to 1430 parts per million. That particular solution is supposed to be compared with Test 2.

Now, you see in Test 2, we have about 2 parts per million of copper, 242 parts per million of lead; and here we have 204 only of lead, but we have shown that the changing of lead does not greatly affect the inhibition; and this is about in the same order of magnitude. Now, we are increasing the iron, about tripling the iron concentration, and we get 61 per cent reduction in corrosiveness. If you will compare that with Test No. 2, you will see that they are about the same; 1.3 per cent is actually shown, but I think the method is—I think 1 per cent would be a permissible variation in tests.

Now, going to the last horizontal line, which is No. 7, we used 3.44 parts per million of copper; 530 parts per million of lead; and 1440 parts per million of iron. That should be compared with Test No. 3, although the copper is a trifle lower, but the lead is about the same—the copper is substantially the same, and the iron is about three times as great.

Q. The lead is considerably more, isn't it, Doctor, in Test No. 7 than Test No. 3? A. Now, wait a minute. Wait until I get this straight now (indicating). 7 and 5 are the tests that should be compared. In Test No. 5 there was 4.18 parts per million of copper; 510 parts per million of lead; 473 parts per million of iron. In Test No. 7 there are 3.44 parts per million of copper; 530 of lead. Copper is a little lower, but the lead is substantially identical with Test No. 5. The iron is more than tripled, just about tripled. So the net change is largely on the iron, tripling the iron. A reduction in corrosiveness is reached of 70.5 in this case, whereas up above there it is 71.4. There is a little more

copper in Test 5, and that would probably account for the difference. But the effect of the iron is shown to be negligible in these tests, there is substantially no effect by adding iron. Lead has some definite effect, and the copper has a very appreciable effect upon the inhibition.

These tests, the laboratory tests, if you compare those with the actual flow tests, they are very comparative; these figures all are of the same order of magnitude. In the laboratory tests we obtained about one-third to one-quarter as much corrosion with the inhibited samples, as we did with the uninhibited acid, and that same thing is true in the tube tests that we made. It is expected in the laboratory tests that we would get slightly lower inhibition because of the fact that there is no agitation in the laboratory tests.

The Court: Let me see if I understand you. In 4 why do you get more than you do in 2, and you have less copper? A. Why in Test 4 do I get more inhibition than I do in 2, when I have more copper? The copper was supposed to be made up to 2 parts per million in the samples. Our analyses shows, as given on the chart, the determination of copper is no more accurate than about .2 parts per million. Therefore, to all intents and purposes, these two samples have the same copper content. The amount of copper added was identical.

Mr. Owen: In Test No. 4 you had more than twice as much lead as you did in No. 2. A. I was coming to that. The copper was within the error of the method of analysis of about .2 parts per million. The lead about 3%. The increase in lead gave about 3% reduction in corrosiveness. Doubling the lead content gave about 3% increase in inhibition.

The Court: Have you got this close enough so that you, with your figures showing the combination, do you think you could work out figures as to how much corrosiveness you would have or how much inhibition, which is the same thing, without analyzing it? A. I think I could tell you pretty close if you wanted to know how many parts per million, if you said what inhibition would you get with 3

parts per million of copper, 400 of iron and 500 of lead. I could tell you that very quickly. The whole thing this shows in a general way is you get between 60 and 70% inhibition with acids that contain iron, lead and copper in such amounts as we got into our Menaul tank acid or in amounts reported in defendant's acid as taken directly from their truck tanks. These compositions cover the range of all those acids and the 10% would cover the whole group. In other words, once you get up to 2 parts per million of copper, a couple hundred parts per million of lead, you get to 60-70% inhibition. You may get another 10% if you double the copper, a little more by doubling the lead, but you are up near the optimum condition of inhibition with that condition of copper, lead and iron. These cover the composition of field samples of Dr. Bartell and cover the combinations of acids we got when we put it in the Menaul tank and shook it up for six hours.

The Court: I am looking at No. 6 and No. 4, and I am wondering why the more than doubling the amount of lead practically made no difference. What was your explanation about that? A. Test 4, the inhibition is 62.7 and in Test 6 the inhibition is 61. That is 1.7 per cent due to doubling the lead. There is not a great deal of change.

The Court: You are more than doubling your lead. A. More than double, yes. It is around two per cent change, and the other figure was three. But in all the tests we have run increasing lead up to about 200 parts per million you get about eight to ten per cent inhibition, and if you go above 200, going to 500, you get another one or two or three per cent, so it goes up to a little over ten as a rule.

The Court: What is your final conclusion about iron? A. That it has practically no effect whatsoever. You don't want to take these figures—I regret they reported these percentages in fractional percentages. The best thing is to take them as whole numbers, and the accuracy of an inhibition test isn't sufficient to warrant these percentages, and therefore I would rather stand on whole number differences.

The Court: I was treating 62 in 7 and 61 in 6 as being

practically the same. A. Yes. You see, Test 2 and Test 6 have about the same copper and same lead, and the iron is tripled, and it is 1.3 per cent difference between the two. And that is coming very close to the sensitivity of the method.

The Court: All right.

Mr. Owen: Doctor Prutton, did you run any other tests than those covered by your tables which have been offered as PX-187, 188 and 189? A. We ran several other tests which are not reported in the report involving running uninhibited fifteen per cent acid through a tubing system. Another test running it through the Menaul tank and then through the system, and one test in which, to the commercial acid, chemicals were added and then it was run through the tubing system direct, and those figures were not reported.

The general results of the tests, the first test run with commercial acid was run as a sort of a measure of how we could rely upon the—how constant would be the rate of corrosion of different lengths of oil well tubing, and we used a set of tubing which was not used in subsequent runs, and we found that the variation in corrosion of different lengths of tubing in that system varied by as much as twenty-five per cent. So we decided in subsequent runs to fix on two completely separate identical sets of tubing that we would follow through in the tests.

The result of the first test agrees in general with the blanks we ran on other samples, or on other tests. But since we did not follow through and run that same tubing throughout all the Menaul and other type tests, we did not include it. The rate of attack of the tubing in that first run was substantially the same order of magnitude as in the other blank runs. It wouldn't change the picture to any degree at all if it were included.

The second run that was discarded was a run that I mentioned this morning in which we ran fifteen per cent commercial hydrochloric acid through the Menaul tank and we tried to do it so fast that it would not have time to pick

up lead and copper. And when we finished up we found that about fifty per cent inhibition had been obtained by the exit acid. The acid from the Menaul tank showed 1.3 parts per million of copper which would account for about that fifty per cent inhibition. And since the result was not clear cut, that was not included.

Then a third test was not included in which we made up a synthetic mixture of these chemicals added to the acid, running directly from the crock through the oil well tubing, and when we got through with that run and analyzed the solution we found that some error had been made in the copper addition, and that the analysis showed about 1.4 parts per million of copper, and that particular acid also gave about fifty per cent inhibition, which is about what we would have expected.

Q. Did you run any tests with oil through the horizontal pipes? Your pipe system? A. We ran tests which were not completed. We put some of this oil from the Zahn well in the tubing, and then ran the acid through the system. The flow conditions that we got in which alternate solutions of the oil came out of the tubing with the acid, and the fact that our tubing system was almost horizontal, which would permit the oil to rise to the top of the acid, and the acid flow underneath the oil, and have a very thick column of oil up on the top of the acid layer, we came to a definite conclusion that those tests were not valid, they did not agree in any way with these laboratory tests of the inhibitions in the presence of oil as reported this morning. The inhibition was around 50 to 60% when measured, which we felt was due to the fact a heavy layer of oil floated on top of the acid, the acid had gone beneath it and we really only had half of the metal exposed. In our tests the velocity we ran acid through our system was a very low velocity—less than a half foot per second; when we pump acid down into an oil well in a treatment, the velocity you usually use is around 5 to 8 feet per second. At that velocity you get a tremendous amount of turbulence which scours oil off the tube; you have no turbulence at one-half foot per second—

it simply flows in a straight line. Therefore, we felt to make any valid tests to determine the effect of oil that might have been in the tubing we would have to go to a vertical system, to have a pump in the system that would give us the velocity, and we did not complete all the data on those tests because they were all experimental, to get any figures that were representative.

The Court: Is your rapid movement comparable to agitation? A. Very much so, yes. If you increase the velocity of a stream of liquid going through, you get a scouring action. The turbulent currents tend to scour off the oil. The more rapid movement, Dr. Bartell's tests have indicated that you get more rate of solution but you get a greater percentage of inhibition.

The Court: All right. That is attendant, on the one hand, with that agitation you get in your flowing down the well. You have your oil and your acid mixed, or not? A. In the horizontal pipe—the oil was at the top and the acid flowed under the oil.

The Court: Now, where would the oil be going down the well? A. If it went down vertically the slug of acid coming into a column of oil would hit a velocity of 5 feet per second and it would be scouring off. You have a slug in there in which the acid and oil mixed somewhat but the acid forces the oil into the tubing.

The Court: In each of those did you think you got a greater oil inhibition, in this agitated one, which would be like the well, or in the oil segregated at the top, and the acid flowing under it. Which do you think you would get the greater oil inhibition on? A. If the acid flowed down the vertical oil well tube at high velocity, and forcing the oil ahead of it, you would get a lowered effect of the inhibitory properties of the oil, a lower inhibition due to the oil than you would in my test where it was simply being run underneath a thick layer of oil that was covering over half of the pipes.

The Court: What percentage do you think the oil was to the balance of it? A. I really don't know what there was in this pipe.

The Court: I was thinking of a very small percentage, like the cream on a milk can, a little skim over the top, of the oil, to a substantial quantity of the acid, compared— A. (interrupting): In this test that we ran, or these preliminary studies to see just what happened when we flowed the stuff through the oil well tubing, the total volume was about six or eight gallons, and there were about two or three gallons of oil there, and it came out in slugs, there was a slug of oil came out every once in a while.

The Court: That would not compare to the total formation. As I understood you, and as I understand it, the oil would be comparatively still, and the other would be flowing under, and, therefore, if you stopped at any one time and compared the amount of oil to the amount of acid, you would not have any fair comparison as to the total percentage of the total amount that passed through the oil? A. I did not feel it was a fair comparison in the test that we could get.

The Court: I was wondering which way the oil worked, though. If it was agitated, you would get a comparatively small amount of oil over the whole surface, wouldn't you? That is, one part of your tube would have as much oil on it as the other? A. Yes.

The Court: On your agitated one? A. Yes.

The Court: Now, in the other, if you are right about the oil being comparatively still to the acid, and flowing under it, I should think you would get almost a complete inhibition right at the point where the oil contacted the tube, and I would think you would get practically no inhibition at the point where the acid contacted. A. That is exactly the reason.

The Court: Therefore I would want to know how much oil you had, how thick the layer of oil was? A. We had no means of measuring that exactly.

Mr. Owen: I understand in this test the doctor first filled the pipe with oil so that the oil was in contact with the entire surface.

The Court: I was in complete accord with him that it

was not comparable at all. I didn't know how you could get anything out of an experiment if you didn't have anything to compare it with. A. Can I answer that further? We had thought of setting up a vertical system. When we started to consider, well, if we want to do a thorough job we will have to repeat all the tests, taking in all of the different tests, it became such a complicated thing it would take years to do, and we feel that the laboratory tests are in general indicative of what would happen.

CROSS EXAMINATION

By Mr. Lyon: As I understand your testimony, the agent that constitutes the guilty inhibitor which you accuse in this case is actually the copper. Is that correct? A. The copper apparently contributes the major part of the inhibition.

Q. Well, I would like you to make that just as definite as you can. Is it necessary that there be any lead or iron dissolved in the acid in order for the copper to produce the effect that you have referred to in your testimony here? A. Copper produces alone the major part of the total inhibiting effect of the final acid contribution.

Q. Without the copper, according to your tests, what is the maximum percentage of corrosion, of reduction of corrosion that you could accomplish by dissolving lead or iron in the acid? A. I thought it would be 10 or 15 per cent. Variable figures were obtained, but 10 or 15 per cent is probably—I am not certain that when you take copper and add it to get an inhibiting power of 60 per cent, and then you add lead in a form so that the total mixture is up to 65, we will say, that the lead only does the 5 per cent job. I have no way of telling. There is no more reason for saying that the lead does just that additional 5 per cent than there is in—there is no reason for holding the copper constant and letting the lead take the burden of the decrease.

Q. If I understand you, it does not make much difference after you get up to 5 parts of copper per million

in the acid whether there is any more dissolved in the acid, or not, is that correct? A. I really cannot answer that question, simply because I think the highest concentration of copper that we have worked on has been a little over 4 parts per million; and apparently in adding copper to the acid, you get your major effect in the first two parts per million, and that the curve comes up rapidly in the first two, and then it tends to flatten off somewhat. In other words, we got about 60 per cent inhibition, as I recall here, with 2 parts of copper per million, and then if you jumped it up to 4, you got only about 10 more per cent.

Q. All right. Now, what can you tell us about less than two parts per million of copper? A. I can only tell you the indication I gave you on a large scale test in which we got 1.4 parts per million through and got about 50 per cent inhibition. In other words, going from 4 down to 2 dropped another 10 off.

Q. Have you any experience with 1 per cent? A. I don't recall we have any figures.

Q. So far as you know it is more or less a straight line relationship below 2 parts per million? A. No, I think that it drops off rather sharply in there.

Q. You don't remember the drops? You don't know where it drops? A. No. I would suspect around 1, but I don't know. In other words, we have gone as low as 1.4 and the drop-off is rather rapid. It dropped off about 10 per cent in going from 4 to 2, and from 2 to 1.4 it went down another 10.

Q. How long does it take this copper to dissolve in 15 per cent hydrochloric acid in the absence of any lead plate bonded to the steel? A. I don't have any idea. We made no tests on that.

Q. One part in a million of copper, or two parts per million of copper is not very much. Do you think you know whether or not you could operate in an oil well with hydrochloric acid in a practical way without picking up one or two parts per million of copper? A. Well, we obtained about six or eight shipments of hydrochloric acid from the

Graselli Chemical Company, which takes a bunch of commercial materials and runs it through a process, handles it several times and ships it out to us and the analyses we got averaged two-tenths of a part per million. I believe that same degree of handling should be carried out without much trouble if conventional methods were employed.

Q. Well now, how did this copper get in this acid in the tests you made in your laboratory? A. It gets in in two ways. Some comes in with the original acid. I don't know how that got in. Some of it comes in—considerable part, by the lead sheet dissolving, the copper associated with the lead dissolves. The rest of it comes in, I believe, from a steel tank which also contains some copper. All steels contain some copper. In the tests we ran the lead sheet in the bottom of the tank became coated with white coating, a lead chloride, that wasn't dissolved in the acid, would not show up in our analyses, and the copper that was associated with that lead reacted and then the lead chloride not dissolved, it is my opinion, went into the acid. In other words, a considerable amount of the lead sheet reacted, then went into the solution. Therefore, the copper going into the acid from the lead was an appreciable amount.

Q. Well, now, did you purposely buy lead plate for your test that contained copper? A. Yes, we did.

Q. Pick one out that had copper in it? A. We did.

Q. Why did you do that? A. Because we had definite instructions the Halliburton Company was using chemical grade sheet lead, which contains copper.

Q. What is a chemical grade of lead? A. I don't know. That is a term.

Q. Could you buy commercial lead plates without copper? A. I recall looking into the A.S.T.M. Handbook, recalling four different grades of commercial lead.

Q. Did any of them have any less content? A. As I recall very definitely there is one—at least one, grade that had practically no copper.

Q. And what was the price? A. I don't know. I was looking at the table of the American Society for Testing Materials.

Q. Are you satisfied if the Halliburton Company employed that type of lead plates in its tanks that it wouldn't obtain the effects which are complained of in this case? A. No. I think that the lead and small amount of copper there actually in conjunction with the oil contact you have in the tube all added to the effect, you still had inhibited acid.

Q. Your testimony then is the Halliburton Company couldn't operate its lead plate system for protecting its tanks without their necessarily somewhere in the system picking up enough copper so as to produce the effects complained of in this case? A. If you used commercial hydrochloric acid, such as normally contains a very minute amount of copper and lead, and if you had a steel tank that was relatively free of copper, if you used pure sheet lead, absolutely pure, I believe you still would be putting inhibited acid into the well when you got through with that; because we have shown definitely that with lead alone, you get a 10 or 15 per cent inhibition that is added to whatever your commercial stuff is, you add that 10 or 15 per cent inhibition, and then you are putting it down the well, and that lead has the property of cooperating with the materials in the well, to give you added inhibition, whereas a number of other inhibitors do not have that cooperative property.

Q. Now, was this property of copper, acting in the manner that you have pointed out here, as an inhibitor, known anywhere prior to its use by the Halliburton Company, do you know? A. I think copper is fairly well known as an inhibitor, copper compounds of various types. I do not recall, I cannot give you a reference, but I am quite sure that some inhibitors have used copper.

Q. Did you know that copper was an inhibitor before you studied this Halliburton system? A. Well, I have a vague idea that I did. I cannot recall that.

Q. As a matter of fact, it depends, does it not, on the relation in the electromotive series of copper to iron? A. I do not think that you can make any blanket statement on the electromotive series.

Q. You used to be able to before the announcement of Menaul's discovery, in the Menaul patent? A. The Menaul

patent follows exactly the teachings of electro-chemistry, at least in principle, as far as the protection of the tank is concerned; but it does not follow it any farther than that, due to distance and various conditions.

Q. You have read the Menaul patent? A. Yes, but I can't remember every word in it. I don't recall that it is.

Q. Didn't Menaul announce a discovery that in hydrochloric acid lead bore the opposite relationship in the electromotive series to iron from anything published before? A. It would be a discovery for any one unskilled in electro-chemistry, yes.

Q. Can you point to any literature showing that discovery before the Menaul patent? A. I can point to the fact that the electromotive force series is a series where each element is given a potential, with a sign to show its tendency to dissolve, but that number that is listed there is the potential of that element against a solution, a water solution that contains one ionic weight of that kind of metal, ions per liter, a definite concentration.

Now, we have equations that show how any voltage changes with the change in the ionic concentration of the solution, and it is entirely logical that although lead is shown in the electromotive force series slightly below iron, when you put it in hydrochloric acid where lead chloride is insoluble, and you get low lead ion concentration, it is possible to figure out what would be obtained.

Q. Didn't anybody ever announce the fact that it was so shifted in hydrochloric acid before Menaul, to your knowledge? A. I don't recall that they ever announced it, because it is one of those things that anybody skilled in the calculation could have calculated quite closely, and the facts that you get a very minute potential tending to give electrolytic protection through the lead and hydrochloric acid solution.

Q. Are you familiar with the fact in acting upon Menaul's patent application the examiner referred to Menaul's statement on that point as inoperative and contrary to scientific fact? A. I read the entire file wrapper,

and the examiner was not highly skilled in electro-chemistry.

Q. Well, then, an ordinary skilled man didn't know before Menaul's announcements of this shift in the electromotive force of the relationship of lead to iron in hydrochloric acid, at least you can't point to anywhere in the prior art? A. I believe that any college graduate that has taken a course in electro-chemistry would know that such a shift would occur.

Q. Now, what about copper? Do you think—where is it according to the text books made prior to Menaul's invention, in the electromotive force, relative to iron? A. It is down below iron.

Q. Always? A. It is usually below iron.

Q. Well, does it shift to above iron, now, in this system of the defendant's? A. Well, when we talk about these potentials we are talking about a solid piece of metal. When we are talking about the protection we get with copper that plates out slightly on the surface of iron, we are talking about not a solid mass of metal but just a few molecules stuck here or there. It isn't the same thing at all. We have no means of calculating, in an imperfectly covered surface of iron covered with a few molecules of copper, we cannot calculate the potential of the copper or of the iron. Therefore, we are talking about something that is indefinite and the question cannot be answered exactly.

Q. Well, according to what was published in the literature prior to Menaul's patent announcement, copper was below iron in the electromotive series, and if added to hydrochloric acid in the presence of iron should have increased the corrosion? A. That is right; that is correct.

Q. Now, can you show me any announcement to the contrary to tell you, until your own work or Dow's work, in examining the Halliburton system for this case? A. I believe that I could get you instances of where copper had been used as an inhibitor.

Q. Where? A. Well, I can't tell you offhand.

Q. Have you got it? A. No.

Q. As a matter of fact, neither you nor the Dow Company or the Halliburton Company knew of this effect of copper which you are relying on in this case until you did this work, or the Dow Company or Dr. Bartell did this work for the purpose of establishing the evidence in this case; isn't that correct? A. I don't believe that is. It is my opinion that the copper effect was known for years before. At the time of the taking out of the Grebe-Sanford patent, I believe.

Q. Will you point to some publication or published statement of that fact? A. I can't do it offhand.

Q. Well, how long will it take you to find? A. I think probably over night.

Q. All right. We will leave that and ask you to be prepared on that in the morning. Well, did you know it before you did this work? A. I believe I did.

Q. Before you started work on this experimental data, did the Dow Company inform you that that was the basis of their position in this case? A. I don't remember.

Q. You didn't discover this stuff about copper in this solution business independently, did you? A. No. I knew of Dr. Bartell's findings as to copper in the samples, and, as I recall, I knew that copper was an inhibitor in the right concentrations when used, and the thing seemed entirely reasonable to me, that it would inhibit. Otherwise, I would have questioned, possibly, the conclusion that had been made by Dr. Bartell.

Q. Why? A. If I believed copper was going to accelerate the corrosion, I would not have swallowed wholeheartedly his statement that copper was the cause of it. Therefore, I was quite sure at that time that I knew that copper was an inhibitor, if used correctly.

Q. Well, you can't find that in any literature, can you? A. Well, I hope to. That is what I said I hope that I can bring in tomorrow morning for you.

Q. Now, how does the copper work? Do you know what its system is or mechanism by which it accomplishes this inhibiting action? A. I believe that both copper and

lead work somewhat similar, and that is that in the dissolving of the iron that hydrogen is plated out on the anodic portion—or, I mean, the cathodic portion of the metal, and that an imperfect film of copper and lead are deposited on those areas that hold on to the hydrogen, and build up a hydrogen over-voltage or polarization that stops or reduces the corrosive cell.

Mr. Owen: May I make a statement here, right in connection with this discussion of the inhibiting value of copper, Your Honor, plaintiff will show that the Dow Company used a copper chloride as an inhibitor for hydrochloric acid in acidizing oil wells for two or three years prior to the date of the Menaul invention. A. That is undoubtedly where I learned of it, and possibly from the literature too.

Q. Is it your testimony then that just putting copper chloride in the solution, without any lead plate, without any galvanic cell action, would accomplish this same inhibition, of the same order of magnitude? A. It would accomplish some inhibition.

Q. How much would you have to put in? A. Well, I think we have shown here how much you have to put in. You have got to put in a couple of parts per million.

Q. Of copper chloride? A. In the form of copper chloride.

Q. Is that all that you have to do? A. Just a few parts per million, and you have got about 50 per cent inhibition, approximately.

Q. Well, now, you were discussing the action of the copper in this plating mechanism, and you mentioned the plating of a film of lead or copper. Is it actually necessary that there be any such film at all to accomplish the reduction in corrosion, or may that be accomplished without the plating action of the metal, simply by the polarization? A. Unless you change the surface of the metal, you cannot get any difference in polarization; and, therefore, that is the basis upon which I am stating that some of that metal must be deposited to change the nature of the surface, so that

it can hold on to that hydrogen better. If there is no change whatsoever in the surface, you would not get any change in polarization.

Q. Wouldn't you get a hydrogen film? A. You would, but it would not take the high back EMF that stops corrosion, or the high polarization. You would get a slight film that would escape in the form of bubbles, and not be held on there tight.

Q. Now, you criticized the statement of the defendant's chief engineer this morning as read to you. I am going to read to you the paragraph commencing at line 38 on page 3 in the Menaul patent covering the defendant's system, No. 2149617. I think Your Honor has a copy of this patent. First I call your attention to the paragraph commencing at line 55 on page 3, reading "The method of this invention may also be applied to the treatment of tanks or other containers in which acid is stored or shipped, a suitable plate of metal having a more negative external potential than iron in the acid solution, for example lead, is suspended in the acid, then connected with the wire of the steel tank either with or without the medium of a battery or other source of low voltage current. As shown in Fig. 5, for example, the iron tank 12 may have a lead plate 13 in electrical contact with the bottom of the container. Such contact may be obtained either by riveting or burning the lead into place. It is to be remembered that the lead plate or lining should not cover the entire interior surface of the tank but only a part thereof so that the acid contained therein may contact with both the lead and the sheet iron. Desired polarization of the interior of the tank is thus attained." Now, do you disagree with that statement? A. No, I think that is true to a degree.

Q. Well, now, I will next ask you to turn to the paragraph in the next column, commencing at line 37, reading:

"It is remarkable to note that casing many thousand feet from the lead plate 15 is pacified. The explanation for this may be that both the acid and the casing are good conductors of electricity, but it is believed that an additional

factor is involved, namely, that as soon as one part of the casing becomes pacified, the resistance of that part immediateely goes up. This is in harmony with the theory that a film of lead or hydrogen or both is formed on the iron since such a film would present a higher hydrogen overvoltage and likewise cause a high resistance to develop. This would increase the current density adjacent other parts of the well. A film would tend to form wherever it did not already exist and once formed would tend to cause the current to flow from the acid to the casing somewhere else which in turn would tend to cause the formation of a film there, and so on, every part of the casing being protected as soon as that part is contacted by the acid."

Now, as I understand your criticism of this paragraph, you do not believe that the forces considered or involved would permit the current effect to reach down the well or down the pipe, is that right? A. It is my contention from theoretical grounds and from the results of the tests that we have made that that action does not occur down to great distances into the tubing.

Q. First with reference to the results of the tests that you have performed, have you examined those tests as to their possible range of error so that you could tell us within what permissible range an effect of the type called for by Mr. Menaul in the patent might have been present in your tests and not been detected? A. It is my belief as a result of the tests that there was absolutely no electrolytic protection due to the lead plate and the hypothesis of the method given in this patent to describe what was claimed to have taken place.

Q. Don't you care to answer my question? A. I can answer it, if you would be very specific as to exactly what you want.

Q. Well, just read—do you want the question read again, and you ask me anything about it you don't understand. A. Let us have it.

(Question re-read.)

A. As I recall, I made the statement that the ac-

curacy of our tests was possibly somewhere in the range of variation of 50 or 70 grams of iron in a test. Now, the fact that in our blank runs we got about 1000 grams of iron dissolving and in these tests with the inhibitors added and in the tests with the inhibitors present the Menaul patent contemplated, we got substantially the same figures. That is the basis on which I decide the electrical connection had no effect.

Q. That isn't an answer to my question. A. That is as close as I can come to answering your question.

Q. You are able to take your own work and from your work report a possible range of error, is that correct? A. Why, I think that is correct, but I can't give you an exact figure. It is 9.1% or 9.2%.

Q. Isn't it true on its face it is not any more accurate than within 20%? A. It all depends on the way you look at it. You are looking at it from the bottom up and I am looking at it from the top down.

Q. If it is accurate only in 20%, the possible percentage of reduction in corrosion, this Menaul effect might exist and not be detectable in your test within what range? A. You mean in reduction of corrosiveness?

Q. In per cents of reduction of corrosion, if your work isn't accurate below 20%. A. It is more accurate than 20%.

Q. Let's assume it isn't. A. Why assume that? I claim it is within 5%. I think it is closer to 5% on the reduction of corrosiveness. It isn't exactly 8 or 10. It is somewhere around 10%—5 to 8, and 5 to 8 is probably closer.

Q. Will you look at your tables, PX-187 and 188 and compare run 2-E, PX-187, with 1-N on table PX-188, and 1-M on that table? What is the percentage of error between those two tests? A. In the first place, the oil well tubing was entirely different in the runs. You have to compare the ones and twos with the same number; you can't do it otherwise with the tubing; you can't cross-compare for the tubings.

Q. You have averaged the runs up there for 100% corrosiveness, haven't you, in both tables? A. That is one of those average of averages that is approximate but not too good. I have stated between oil well tubing you get a difference of 20% and that means between the two sets of tubing you can't cross-compare. You have to compare one to the other—you have to compare within the one set, and then you compare No. 1's with No. 2's.

Q. Does that mean—within what range could these findings of yours differ within the results that you could get from different oil well tubings, or different lengths or combinations of oil well tubings? A. I have said that the rate of corrosion of one length of oil well tubing with any acid might be 20 per cent different than the results of another length, and that is why we used the same tubes in a series of tests; you have got to compare the ones marked No. 1, with each other; and the ones marked No. 2 with each other.

Q. What is comparable in your tests then—you should not compare the No. 1 runs with the No. 2 runs? A. No.

Q. They should not be compared? A. There the difference might be 20 per cent between those.

Q. You have got to compare the No. 1's with the No. 1's? A. Yes.

Q. You haven't got any No. 2 runs with the same amounts of materials present, for comparison as to their accuracy? A. Do you mean in these—oh, none of the Menaul patent. We have got two 1's and two 2's, but you mean any test where they ran the synthetic—

Q. I mean, in the Menaul— A. (Interrupting): Here are two 1's and two 2's (indicating).

Q. Well, they have different amounts of material? A. Not a great deal.

Q. Have they got enough to account for the difference in the results? A. Not much. I don't think you would get a great deal of difference between the concentrations that you have there (indicating).

Q. How do you know that you would not? A. I don't

know, but with that little difference in copper, I would expect it to explain some slight difference here (indicating).

The Court: Let me ask you this, doctor. I was taking a tubing X and tubing Y, and you make up two different compounds of acid and we will call one of those A and we will call another one B. Because one of them—they will all have hydrochloric, both A and B have got hydrochloric in them, and both A and B have got copper, but we have shifted different amounts; and they have both got lead, but we have shifted so that A and B, while they contain the same three elements, they don't contain them in the same proportion. Now, you have got X and you have got Y, two different commercial pieces of tubing. Now, if I apply A to X and Y, and I find that, we will say, X is consumed faster than Y, does it follow that if I apply B to X and Y that X will go faster than Y, or are there some combinations upon which you will get the reverse in the consumption? A. It is my recollection from our data that there are no exceptions to that rule, that you will always get the relative positions. Fairly close. Now, the differences that are being discussed here between 4.3 in test run 1-M, and in run 1-N, 3.25 parts per million of copper, can explain any differences between those two, due to that difference in copper. We have shown when it gets up near 4 it sort of flatens out, that is, that the curve is flattening out, and that the difference we would expect from that is not very great; it might amount to a couple of per cent here, and I am willing to admit that. I am willing to admit these numbers are off four or five units, and I have said there could be a five to eight per cent variation in our test results.

By Mr. Lyon:

Q. Will you explain the difference between run 2-E and run 2-B on the other exhibit, PX-187? What is the per cent of difference there between those two? A. The percentage of difference is from 66½ to 89.1. The difference is 22.6 per cent.

Q. Now, how do you account for that? A. Well, this

particular one contains .73 parts per million more copper and it is down lower in the range where the effect of copper cutting off seven-tenths of a part per million makes a greater variation, and that would account for some of this difference.

Q. How much? A. I don't know.

Q. Well, now, what is the per cent of error, do you know, whether it is actual error, in comparing those two runs? A. No, I don't know. It would cut back the difference somewhat, probably 15 points, or something like that, in error.

The Court: Do you think if you had analyzed these—that gets back to a question I had previously—and I suppose there are so many different comparisons that you haven't analyzed that I could find some new ones, but this is the same question. Suppose before you analyzed 2-B, that combination, made that test, and before you had made the 2-E, how close do you think you could have come to telling what the percentage of reduction in corrosiveness would be on 2-B, and how near do you think you could have come to telling how close it would be on the other? A. I think run 2-E is possibly one, and the comparison there is possibly one that shows the greatest variation in the series between those two.

The Court: You actually ran this and you are giving me the actual figures? A. I would think you could tell within five to ten points, which is about the figure that I gave you before. Now, I might miss it a little greater than that, but I don't think so.

The Court: You don't think you would have gone lower on 2-B, you don't think you would have guessed lower than 60, or higher than 70 then on that. You think you would have gotten it that close? A. I think so.

The Court: And you think on 2-E you wouldn't have gone that far? A. I wouldn't have gone that high, because that is a little higher inhibition than the rest of the figures would indicate would come. I think that is a little higher inhibition. That is up in the upper end of the

thing. I would cut back five to ten points on that, and call it 70 to 80 or 80 to 89, somewhere in there.

Mr. Lyon: I still want to talk about comparing 2-E with run 1-M.

The Court: All right.

Mr. Lyon: You tell me that is a different pipe? A. Yes.

Q. You have figured the particular pipe for determining percentage of corrosion on PX-188 for run 1-M as against the pipe that was run and called that 100 per cent, haven't you, or you have averaged it out, the difference in those two pipes? A. Yes.

Q. How can you account for the difference between 66.6 per cent reduction in corrosiveness for run 1-M where you have 4.33 parts per million of copper, and the results of run 2-E which we have just been discussing, where with a less amount of copper you have 89.1 per cent reduction? A. Just in the nature of the tubing. That is the only explanation I could give you. It is different tubing.

The Court: We have taken the same acid in each? A. Substantially.

The Court: You have taken the amount you would eat 100 per cent to start it with? A. Yes.

The Court: Well, then, it seems as though that—you have already accounted for all the differences in your tubing right there, in that difference in the 100 per cent? A. No.

The Court: I take it one would eat more than the other? A. It wouldn't account for all the difference. It would account for half the difference here. If your rates of attack are known for two sets of tubing and average them, you are half way off.

By Mr. Lyon:

Q. Did you do this, Doctor, or did somebody else inflict it on you, this average of averages you have got in these tables? A. I believe somebody else inflicted it on me. I don't remember. I think the field of comparison is on one side of the tubing and to simplify the thing it was thrown together.

The Court: Well, then, that is the only average of averages, that top line? A. The top one. The rest are individual, and we are comparing an average of averages of attack on these blanks.

The Court: For the purpose of getting at what I was asking you about we should have that performed with the same acid in both cases, and take what they eat as 100 per cent? A. Yes.

The Court: Isn't that right? Then we would get at what I am talking about. A. In one set of tubing we got about 1000 grams and the other set about 800, and there was 20 per cent difference between the two sets of tubing, and so what we have done at the top figure, we have averaged up those two rates of plain acid and to compare the individuals and it is not a valid comparison and produces some little difference.

The Court: We can't get at what you are getting at at all? A. The whole question is entirely an academic one in that we are showing these acids are 60 to 80 per cent inhibited, plus or minus 10 per cent, and that is the story, and to argue on differences of 5 to 8 per cent is simply wasting time.

Mr. Lyon: If it is plus or minus, if these results are plus or minus 10 per cent we will say— A. (Interrupting): No, I wouldn't say that.

Q. I thought you did. A. I said a range of 10 per cent. All of these acids are different. All lie within 20 per cent outside range of inhibition, and they are all very highly inhibited.

Q. Well, your statement is, as I understand it, that your tests with the Menaul tank system, which you have already described, establish that there is no effect of connecting the tubing to the tank, unless it be within the limits of error of the tests that we have been talking about, is that correct? A. The limits of error I hadn't fixed exactly.

Q. You haven't fixed them? A. I haven't fixed them exactly, and there is no effect of the Menaul process on the portion of the tubing.

Q. Now, you have stated that, on a theoretical basis, current cannot get down the pipe, or get the acid down the pipe? A. I say, the probability that it is going to climb down that acid through a tremendously high resistance, when it has got other and a lot easier ways to go, I say the probability is so remote, and we find such a small amount of current flowing between the pipe and the tank, that most of that current undoubtedly took the easy way, and the minute amount, a trillionth of an ampere might have gone down to the bottom of the well, but I cannot tell for sure that any amount did that was effective to do anything.

Q. This is purely a matter of opinion as to how much of that current gets down? A. It is purely a matter of opinion, based upon a knowledge of the flow of electricity in certain circuits, and electrochemistry, and an agreement with the results of these tests which we have run.

Q. Isn't the resistance of the acid low enough so that theoretically the current could get down appreciably down the well, even 5000 feet, assuming that the formation of the film on the walls proceeds as the acid goes down? A. That question was asked by Judge Tuttle, in which he questioned the relative conductivity of the metal and the acid, and I gave him the figure, I said that the acid was not as conductive as the metal. I gave him a figure, but I guessed at it. I have looked that up, and instead of the metal being 5000 times as conductive, it is 100,000 times as conductive as the acid.

Q. Where did you find that? A. Those figures are from the handbook.

Q. Will you just get your handbook and tell us what the resistivity of hydrochloric acid is, 15 per cent? A. The reason I could not make any certain calculation of this is that in talking of the resistance of metal, we used specific resistance. In talking about solutions for theoretical consideration, we talked about equivalent conductance. You cannot convert one into the other—to convert one into the other is a difficult thing to do so that it can give you an exact figure. This is the Handbook of Chemistry and

Physics, Twenty-Third Edition, and the equivalent conductance, page 1529, the equivalent conductance of aqueous solution of hydrochloric acid is given as varying in different concentrations of solutions from—a very dilute solution of 379, and a one-tenth normal solution of 350. And from that you can calculate out that the specific resistance of hydrochloric acid, if you take a centimeter cube of hydrochloric acid and apply a potential of one volt across two opposite parallel faces, when you have a resistance of one ohm, a current of one ampere will flow, and that is about the resistance of this hydrochloric acid. It is very close to one ohm.

Now, if you take a cubic centimeter of steel, on page 1531 of this book, steel is given as varying, different kinds of steel, but here is one steel, 10.4 times 10^{-6} ohms centimeters. That is the resistivity of it. In other words, 10 times 10^{-6} is 10^{-5} or 1/100,000. Its resistance is but 1/100,000 of an ohm for such a cube of steel. And a cube of hydrochloric acid has a resistance of one ohm. That is the ratio of the two.

Now, in a well there is a bigger cross-section of hydrochloric acid than there is of metal and it becomes difficult to calculate the exact ratio of conductance.

Q. Would you think that the resistance through this 5,000 feet of hydrochloric acid, fifteen per cent, that the value of, say, 4,000 ohms was about right? A. You have to know the diameter of the tube and everything else?

Q. Two and a half inch internal diameter oil well tubing. A. Well, let's see, two and a half inches would be about—how long a tubing was it again?

Q. We have been talking about 5,000. We might as well see if the currrent will get down there. A. All right. I will figure this out.

Mr. Lyon: If Your Honor please, aren't we entitled to look at the books recording the actual experiments to which the witness is referring? I asked him to produce them. Who has got the books? A. Right over there. Mr. Lightfoot, have you got those two books? Give them to Mr. Lyon.

Mr. Lyon: Now, we were trying to figure the resistivity of the acid down—what the total resistance would be in ohms for 5000 feet of acid in a 2½ inch bore? A. You gave a figure of 4000. I came closer to 5000.

Q. It is somewhere between 4000 and 5000 ohms? A. Yes.

Q. Now, did you determine what the available voltage is, effective voltage is that is created in the system in the Menaul type of tank? A. Yes, I have those figures.

Q. About the order of one-tenth of a volt? A. An average of a couple hundredths of a volt.

Q. What is the figure in the Menaul patent, without taking the time to look it up? A. I have seen figures of 35/100ths in this.

Mr. Owen: I would like to have you refer to your notes, Doctor, and give the exact figures. A. I will give the exact figures. Do you know where the voltage is mentioned in the Menaul patent? I can't pick it out right offhand.

Q. You start in and give us the voltages that you found and I will see if I can find the voltage in the Menaul patent. A. All right. Should I read these figures?

Q. Yes, if you have them. A. When the tank was full in run 1-N the millivolt difference between the tank, which was at the start of the test, the millivolt difference in potential between the tank and the pipe was zero, and the microamperes—

The Court: Tell me what that means. A. That means the difference in voltage. You put an accurate voltmeter between the two and there was no potential difference between the tank and tube and there was no current flowing at the start of the test. When the acid had fallen down from 40 inches deep in the tank to 34⅛th inches deep, in other words, when about one-sixth of the acid had gone through, the millivoltage, the voltage between the tank and tube was 1.2 millivolts. That is .0012 volts. And the tank was negative. And the micro-amperes that was flowing at the time was 2½.

When it was 26½ inches—28½ inches of acid left in the tank—I can't make that number out. It may be 26 or 28. It is not typed very clearly, but the tank was about one-third empty at the time, there was 1.8 millivolts difference in potential between the tank and the tube. The tank was negative, and 5 micro-amperes was flowing through the electrical wire, 5 micro-amperes would be five millionths of an ampere.

The Court: What was it in millionths? A. Micro.

The Court: Five in a million? A. Yes.

Q. You were telling about this wire now? A. Yes.

Q. What I am interested in is the voltage that is set up in this circuit in the tank? A. You mean inside of the tank?

Q. Yes, between the lead plate and the acid. A. I couldn't make any measurements there.

Q. You didn't make any? A. We couldn't.

Q. You could have. A. How? I would like to know. I couldn't figure it out myself. Maybe you can tell me.

Q. I should have asked you, couldn't you? A. Not with my knowledge.

Q. There is no way of determining the available voltage in this galvanic cell that is created in this tank? A. Well, I entered the work in this lawsuit with the idea that we were going to see whether this tank with the lead in it inhibited the corrosion of the tubing. I was not interested in the tank, so I didn't even give it much thought, but just offhand I couldn't tell you how exactly to measure that in that peculiar shaped fashion.

Q. The point is that you did not measure it? A. I did not measure it.

The Court: When you measured the wire, that does not measure the other current? A. It does. It absolutely measures the current.

The Court: It is your theory that it would measure it, and it is your theory that it would not? A. May I state this here, we measured the amount of current that flowed into the copper wire from the tube to the tank. Now, that

is the current that had to go down in the acid, in the tube, and then come back through the tube back to the tank, and that is what we were interested in. He asked me whether we measured the current that flowed through the lead plate. We didn't do that.

The Court: Your theory is that that goes from the lead to the iron, through the copper down into the tubing and back through the acid? A. No.

Mr. Lyon: That is just wrong if that is his theory. A. It is just the reverse. It goes from the lead to the—in order to do any protecting, it would have to go from the lead up through the acid, inside of that tube all the way down to the bottom of the well, back through the well tubing and back into the tank. In that circuit we put a microammeter and measured how much current was flowing in the tubing, and it measured the amount of current that went down to the bottom of the well.

The Court: I have been misstating everybody's theory. I had—all I did was make the current flow in the wrong way. Of course, it has got to flow in one way to make it deposit on the lead. A. Yes, Mr. Lyon, with our theory.

Mr. Lyon: You are in general agreement? A. But the question you have in mind is did we measure the amount of current that went from the lead plate to the walls of the steel tank. That is the question.

Q. Through the acid. A. Through the acid to the walls of the steel tank. And the answer is, we did not.

Q. As a matter of fact, just to clear the matter up about this current coming back up from the bottom of the well through the oil well pipe, in effect the system, the tank and the pipe are both grounded, are they not? A. Yes.

Q. So you have got a circuit from the— A. (interposing): Did you say the pipe and the tank were grounded?

Q. Yes. A. The tank is not grounded.

Q. It could be. A. You have it on rubber tires on an automobile.

Q. Connecting to the pipe is the same effect as grounding the tank, isn't it? A. It is connected through another electrode to the ground.

Q. Yes. A. But that is not the same as grounding itself.

Q. I understand. But when this tank is connected by this cable to the pipe you are accomplishing what you would accomplish if you grounded the tank? A. Yes.

Q. And the pipe is grounded? A. Yes.

Q. At the well, is it not? A. Yes.

Q. So that the path of current is from the lead plate—is from the ground through the lead plate, through the acid, to the tank, to whatever metal you are going to protect, isn't that it? A. From the lead plate through the acid to the tubing.

Q. Yes, to the ground. A. No. Some of it comes back.

Q. It is grounded, though. A. And the amount, you can't predict or calculate the amount.

Q. Now, that is what I am getting at.

The Court: Then you only got part of it when you measured your copper wire; is that right? A. The amount is, which I would expect to flow to the ground, is not a great deal. The voltages that we have here are indicative of the driving force tending to drive current from the tank with the lead sheet in it, through the acid into the tube and into the ground, or, it is rather—

Mr. Lyon (interposing): Well, now, suppose we are interested in whether or not we are getting any protection at 5,000 feet down the well. Are you able to state what the magnitude of potential would be or would have to be to set up down there in order to polarize? A. I can't tell you that.

Q. Well, you can't actually prove, can you, that there is not sufficient current there in this system? Theoretically in your opinion there isn't but you can't prove your point. A. The potentials that we have measured, the currents we have measured are all so minute, the patent talks about 3/10 of a volt, or 2/10 or 1/10, and here we find one thousandth of a volt to drive current down the acid, and it is impossible, in my opinion, that any much greater amount

of current than what we measured went down that well bore. I don't know what the patent said. I am just saying it indicates an appreciable voltage, but your advertising literature said 35/100 of a volt. It doesn't—

Q. (interposing): The patent doesn't say anything about tenths of a volt. A. It doesn't?

Q. I can't find it. A. I assume it said an appreciable voltage.

Q. It says in an ordinary cell the voltage causing the current which is required for polarization is very low, being about 100 millivolts. He says that at page — A. (interposing): That is 1/10 of a volt. I think that is where I got the idea of 1/10 of a volt. When measured, the voltage was one thousandth of a volt.

The Court: Where did you measure that? A. Between the tank and the tube.

The Court: Well, in the copper wire there? A. The copper wire was temporarily—put this across the ends of the copper wire, we put a millivoltmeter and it measures the difference in potential that occurs across there.

The Court: Where was it you got that two and a half to five? A. Two and a half microamperes flowing through the copper wire. The quantity of electricity flowing.

The Court: And what is the one and— A. (interposing): Millivolts?

The Court: Yes. A. That is one thousandth of a volt. That is the electrical pressure that is tending to drive current from this lead plate down through the acid in the tubing, down to the bottom of the well, that one thousandth of one volt.

Mr. Lyon: Now, you have said you can't tell us how much electrical pressure or potential would be required down the well in order to polarize it, the pipe. Is that because you haven't determined it or is it because it could not be determined? A. I can tell you that in the electrolytic protection of pipe lines that they have to use .3 volts, and that is standard practice, and I can give you many references to it that are well known and accepted. If you

get below .3 volts they get imperfect protection, and the amount of current that they use to accomplish that portection is a considerable amount. These figures are negligible compared to those figures actually used in that electrolytic protection.

Q. I am not asking you that. If you would just follow my questions, it is somewhat difficult for me to phrase them in this technical subject, I think we could make better progress. I asked you whether or not the fact that you answer that you did not know what potential or driving force was necessary to polarize the pipe at 5,000 feet was because you hadn't ascertained it or because it could not be ascertained? A. We did not ascertain that.

Q. Could it be ascertained? A. I don't think it could be easily ascertained. You could, in a laboratory, set up some sort of apparatus, but to try to astrabalate from that down to the bottom of this well, with the complex electrical conditions that you would have to figure, would be no practical figures whatsoever, and I made no attempt whatsoever to do that, and we feel that these figures being so minute down to the millionths of an ampere, and thousandths of a volt, are so negligible—if you would take that rail out here in front of the lawn you would find one thousandth of a volt difference between the different ends of it, and there is not supposed to be any electricity flowing in it, and the amount is so negligible that as far as I am concerned there is no electrical flow there.

Q. Well, Doctor, as a matter of fact, even that order of pressure or potential, say one thousandth of a volt, is not enough to accomplish the polarization, you say? A. I would state that it would be my opinion that it would not be anywhere near enough to establish polarization, but I can't tell you on the basis of any exact tests.

Q. Well, then, your testimony that there could be no current flowing down the acid in the well sufficient to produce a polarization anywhere down the well, is purely a matter of opinion and speculative opinion at that, not one that you are able to prove? A. No, it is on the basis of

my knowledge of electro-chemistry of electric circuits and the results of these tests when made with oil well tubing that showed if you had that pipe polarized in the tests we made, polarized sufficiently to do any good, we would have a sufficient amount of iron dissolved but we got no noticeable difference.

Q. Subject to the limits in your error, of course? A. I have stated the limits in error.

Q. Now, are you testifying that the current wouldn't be sufficient to cause any polarization in 5000 feet? Are you of the same opinion the same difference would go all down to the ground? A. I would say within 50 feet of the connection any polarization you get would be negligible. I might admit it within a few feet of the wire and in the tank I have admitted it definitely, but even that is stretching my imagination considerably.

Q. Let's talk about the tank a little bit. In the first place, would it make any difference, if so, tell us, if a copper plate was substituted for the lead plate that is bonded in this tank? A. If you put a copper plate in place of the lead plate, I don't know what it would do. I think that your copper would dissolve, some of it would plate out upon the iron, and whether it would plate out in the correct form to do inhibition, I don't know.

Q. I thought you told me a little while ago there wasn't anything to Menaul's announced discovery of the shifting in the electromotive series of lead and copper in hydrochloric acid that any school boy or high school graduate could not predict from calculation. A. Offhand, on copper I can't tell you. You have to get solubilities of copper, hydrochloric acid, coefficients, and with that information it would be possible to go through and make calculations.

Q. Don't you think the first man that had ingenuity or sense enough to do that in the case of lead was entitled to discovery? A. I would say he is entitled to discovery if he had patented his discovery, but he patented the use

in an oil well. He discovered you could protect the tank with a lead sheet. He casually mentions it in the patent.

Q. Casually? Figure 5 shows a tank. A. Well, that method is treating an oil well.

Q. Well, Mr. Menaul was working with a company engaged only in the treating of the oil well business. A. May I read a part of the patent—"A method and apparatus for handling acidic solutions." The examples, there is only one case where it shows the tank alone with the lead sheet. There are three, four illustrations showing methods of using it in oil wells.

Q. Different, aren't they? A. Somewhat different. But it implies in the description, the specification is readily practical on protecting the tubing and casing and parts of the oil well.

Q. What do you think he should have patented as a discovery? A. A storage tank with a sheet of lead. I think he should be given a patent on that.

Q. You do? A. Yes. I think that had some little element of invention on that. I don't want to qualify as a patent expert.

Q. We are not suing on it so you don't have to worry about that. What would happen if you substituted a copper sheet for a lead sheet? Why can't you tell us that? A. Because I don't have the data needed to give you that.

Q. You think you could calculate it? A. Yes.

Q. Sure? A. I believe so.

Q. Do you know what might happen? A. No.

Q. What do you think might happen if you put a copper sheet in that instead of a lead plate? A. I can't tell you.

Q. What do you think happens in this system of the defendants to the tanks if the bond disappears between the lead plate and the bottom of the tank? A. I would believe if the bond disappears that you would get less lead and copper going into solution, and that the tank, because you would not have—you would have a lower inhibition due to lead and copper in solution, and you would have elimi-

nated this small amount of electrolytic protection, but you would get a more rapid attack on the tank, and the tank would dissolve.

Q. How fast do you think, comparatively? A. I couldn't tell you that. That is an impossible question to answer.

Q. Why not? You have made all of these measurements? You have studied this system? Why can't you tell us how long an average tank would last with this system? A. That is like asking a geographer who has made a study of Michigan to tell you how China is put together. He knows the general hills, the valleys and the mountains, and he knows the contour of Michigan, but that does not mean that he can tell you about China.

Q. Let us say that the tank is inhibited 60 per cent in one case, and 99½ per cent in the other. What difference would there be in how long they would last? A. If those figures were—well, it would mean eight times as long as the other.

Q. Now, as a matter of fact, have you inquired at all as to how long these defendant's tanks last? A. I have not been interested in how long they last.

Q. Would you think it probable that the defendant is still using the same tanks that it started with in Michigan in 1935? A. I think it would be highly improbable, from our tests, that they are using the same tanks, if they only polarized them once.

Q. Do you think that it would be necessary that they be polarized more than once? A. Yes, that is my opinion.

Q. Are you quite sure of that? A. No, I just say it is my general—I can't tell you exactly, but in our tests we had so much iron dissolving from the tanks, the Menaul type of tank, which we polarized once, that apparently that protective coating of the lead that you plated on when you polarized it was taken off, and it was not quite as good a job.

Q. Maybe you didn't do a very good polarizing job. A. Well, we bought a brand new automobile portable stor-

age battery, about 100 amperes an hour capacity, and put the thing in and let it go overnight, just the way the defendant did in polarizing their tanks and we used one of these little tanks, instead of using 1000 gallon capacity tank where the surface would be greater.

Q. I won't ask you to be responsible for my statement that the tanks are still in use here, the original tanks, and there are no facilities for polarizing here when they are made at Duncan. I won't ask you to be responsible for that. Can you estimate how long a tank would last in ordinary service if this lead plate was not bonded to the bottom of the tank?

Mr. Wiles: Mr. Lyon, how frequently is the witness to assume the tank is used, how many hours a week?

Mr. Lyon: How many hours do you think it would last with acid in it? A. I couldn't tell you that.

Q. You couldn't? A. No, I couldn't tell you that.

Q. Now, let me see something about these tests you have run. You took the freshly polarized tank and conducted your check tests in it with commercial acid first? A. We took the freshly polarized tank and washed it out thoroughly, and then we prepared the 15 per cent commercial acid.

Q. You washed the tank? A. Sure.

Q. Did you do any scrubbing with this wire brush that you were talking about? A. Absolutely not.

Q. You didn't? A. We might take that polarized lining off if we did.

Q. And you ran that acid down this tubing for testing? A. Yes. Then we put the acid into this Menaul polarized tank and stirred it every fifteen minutes with a big, heavy glass stirring rod about four feet long, by hand, without scraping the sides, for the six hours, and then we started to run the acid through.

Q. That took about three and a half hours? A. Around three hours.

Q. And that was what you called Test No. 1? A. I don't remember.

Q. 1-A. I was trying to get your system there. The one relates to the tubing? A. 1 is the tubing system.

Q. A is the test with the commercial acid without anything in it? A. I don't know the numbers there. I can't tell you.

Q. After you got through with that test what did you do? A. You mean after the Menaul test?

Q. Let us go back to the tests you made at the beginning when you just used the crock? A. Yes.

Q. The first test you made? A. Was commercial acid through the tube.

Q. Then what did you do? A. Then commercial acid in the Menaul tank.

Q. How long did you leave that commercial acid in that tubing uninhibited in that first test? A. In the tubing?

Q. Yes. A. I didn't leave it at all.

Q. I mean it took three hours to go through, didn't it? How much did you put through there? A. We put 200 gallons through in each test.

Q. You put it in at the rate of a gallon a minute and took it out at the bottom at that same rate? A. Yes.

Q. That took how many hours? A. Three hours.

Q. Now, then, when you got through with that test, what did you do next? A. Then we ran with the wire disconnected.

Q. No, I haven't got any tank in this. I have got the crock. And you are just running the commercial acid. A. We took the commercial acid in the crock, adjusted the temperature, then ran it through the tubing system. That was our blank. Just commercial acid through the tubing.

Q. Yes. A. That is one test out of the way. We got 1000 grams of iron. The next test we took the 15 per cent commercial acid in the stoneware crock, blending it up to the right strength and temperature. We ran that through a Pyrex tube down into this Menaul tank which was sitting somewhat below to the side of it and kept it in the Menaul tank for six hours, during which we gave this occasional stirring, and then at the end of that six hours in the

Menaul tank with the wire connected to the tubing, we transported at the rate of one gallon a minute through that tubing, down and out the sewer.

Q. All right. Was that the same tubing you used in testing for the commercial acid? A. That is what the 1 refers to. The 1 refers to the same tubing which was used in the commercial acid, the Menaul acid and so on.

Q. How many different tests did you make with this No. 1 tubing altogether? A. I would have to look through our records, but I think that there was several. I think there is one or two tests, maybe not even that number, that were made on the No. 1 series of tubing that are not shown on these charts.

Q. In all these tests you have the acid in there about three hours? A. The time of running it through the actual tubing system was three hours and 180 gallons was run through.

Q. How many tests did you make with this tubing altogether? A. On one set of tubing?

Q. Yes. A. About five or six.

Q. How many of those tests were with raw commercial acid? A. Two.

Q. Now, did you do anything to the tubing between those tests? A. Yes.

Q. What did you do? A. We took the tubing out, we washed it out and filled it with 15 per cent commercial hydrochloric acid, let it stand for an hour, dumped that out, washed them out again, put solvent through to dry it, and then we reamed the tubes out with this stiff, hard wire brush and put a burnished surface on the inside of the tube, and took all loose metal out, and we got a condition more or less reproductive of the surface of the inside of the tubing.

Q. How thick was this tubing, ordinary oil well thickness? A. Well, it was 2.4 pounds per foot of length and it was about 1/8th of an inch thick.

Q. Am I correct that this tubing got—was subjected to a good deal of action from hydrochloric acid? A. Not a great deal.

Q. It was not? A. We ran two preparations.

Q. That would be seven hours? A. Two preparations, that is six hours.

Q. Six hours. Now, let us talk about that. Did you find the tube was still in good shape when you got through with those two runs? A. Well, it was pitted after those runs.

Q. Badly? A. It was definitely pitted in that time and I couldn't tell how badly, but at the couplings the threads were pretty well chewed up.

Q. Did you have to put new threads on? A. No, we simply tightened them up a little more.

Q. As a matter of fact, your tube was in good enough shape so that you could start out and still use it, couldn't you, after all these tests? A. But these tests have no relation—

Q. I am not asking you to argue. A. To perform this test and put in service these—

Q. I am not asking you to argue about anything. The tubing was still in good enough shape to make more tests? A. I would say that it is not.

Q. It is not? A. Yes.

Q. Isn't that it? A. I would say that we were getting right close to the end. There are threads right on the lengths of tubing, and the acid has eaten into the collars. The last times we made the tests, there would be a drop of acid coming out of it, and we couldn't tighten it up.

Q. After your first test, the first time that you ran the raw acid through the tubing, it was still in good enough shape to continue to make four or five tests, isn't that correct? You did make four or five? A. Well, we did, sure. We felt it was good enough for that purpose.

Q. You say it was pitted. Did you get all of those pittings out of there by your treatment? A. I believe we did. The surface, when we examined the tubes after drawing the stiff wire brush through, was quite highly burnished; it wasn't exactly smooth, but most of the pitted effects had not been completely smoothed out, but at least

somewhat smoothed out. We couldn't see in any too great a length in the pipes. We could see in for six or eight inches, possibly look through the whole length, but not to look down into the pits.

Q. How do you know that there were serious pits in there? A. I did not say that there were serious pits in there. I said it was pitted looking. In one run of these Menaul type acids, and inhibited acids, it showed a matte finish that did not have this pitted effect, it was much smoother.

Q. How deep were those pits? A. I couldn't tell you that. We made no attempts to measure it.

Q. You could tell that by just running this wire brush through there? A. We got a substantial number of them out by doing that, and the surface of the tube was, we felt, substantially the same as the surface before, but there may have been some of the pits remaining. I do not know.

Q. Did this tubing get noticeably thinner in all of these tests now that you have made, four, five or six tests of that tubing. A. We only ran two tests for three hours, with a total of 360 gallons of uninhibited acid, and that did most of the corroding, so the actual time was only for six hours, and I don't know just how thick it was left, but if you figure how thick a layer of iron is—well, we took off that tubing in the two uninhibited acid tests, we took off about four pounds of iron.

Q. And how deep was that? A. I think you and Dr. Bartell figured out something on that, a few thousandths of an inch. But we did not take it off uniformly. It was very definitely in the uninhibited acid.

Q. If the corrosion is not going to work uniformly, but is going to work in concentrated areas, what happens to the effectiveness of an inhibitor if it is only, say, what you call fifty per cent inhibited? A. I do not know what kind of an answer you want me to give you to that question.

Q. Well, as you concentrate the corrosive effect of your acid you are concentrating any residual corrosive effect of your acid, are you not? A. As you concentrate the acid?

Q. The action of the acid; assume that the acid will get in particular areas more than an average over the whole pipe? A. The general consensus of the—the result that I have seen by observation of these laboratory tests is that when you use uninhibited acid, you get this pot-marked or pitted effect; and when you use inhibited acid, you get a smoother surface not nearly as much eaten away.

Q. But that is not what I am asking you at all? A. No?

Q. We have been talking about this on the basis of trying to get an effect of this corrosion, on this uniform effect over the area of the metal that the acid is acting on, and you suggested that they ought to start this out as expending itself more violently in particular areas. A. Well, I have explained here in discussing the theory of corrosion how corrosion usually, unless it is inhibited, does do this pitting action. It attacks these areas that are annodic and therefore you are to expect pitting at these high potential places. When you put inhibitor in that, you have a smoothing-off effect.

Q. If that is true and your acid is going to act that way you are not going to get much good out of 30, 40, 50% reduction in corrosion, are you? Just think that over. A. I think you would. I think it would be very effective as compared with the uninhibited acid; you get a less pitting.

Q. Would you? With only a 50% reduction in corrosion? A. Yes.

Q. If acid is going to concentrate at a certain point— A. (Witness interposing): These acids ran up to 60 or 80, the ones with lead and copper, and they gave a smooth finish.

Q. Well, if you are in danger of having pitting, can you stand for an acid that is 10 or 20 times as corrosive, as effectively, say, so far as 99% inhibited acid is concerned. A. I would hate to answer that question because it involves too many guesses on my part. I would think that it would be very much superior, very much superior than the raw acid. The raw acid, particularly if used with inhibition to

get this 50% effect, a type of inhibitor that cooperates and gets an added effect of a small amount of oil left in the tube so you might start out with 60 to 80% inhibited content, and that same amount left in the tube picks up to 80 or 90%, you get very good results.

Q. The judge suggested a while ago putting something in this acid so it won't burn your hands. Does 15% hydrochloric acid burn your hands very quickly? A. It doesn't burn my hands. I don't know, someone less accustomed—

Q. (Mr. Lyon interposing): Let's take a sulphuric acid. A. 15% sulphuric?

Q. Let's take an acid that would burn. A. It might.

Q. Let's take a normal sulphuric acid; that will burn your hands fairly quickly, would it not? A. It will burn fairly quickly, yes.

Q. It will burn so quickly just diluting it 50% or adding the inhibitor the judge had in mind earlier in the day in the case wouldn't do you much good, would it? A. What do you mean? Adding 50% water? Cutting its strength in half wouldn't do much good.

Q. I can take my hands and put it in commercial sulphuric? Well, if I have the wrong example—what I am getting at is this: Suppose you had an acid that had marked burning effect on your hands, and when you got through cutting it down 50%, that effect, it still would burn your hands very badly. Now, then, if you had a sore on your hand so that the acid could cut it down 50%, that effect, it still would not do you any good at all, would it? A. I don't think the analogy has any relationship. It is just like asking me what would happen if I drank a bottle of sulphuric acid.

Q. All right. You have a lot of figures here about per cent corrosiveness. Tell me how much damage to an oil well pipe, as a practical manner, putting down some 3000 gallons of acid, or commercial hydrochloric acid, at the rate of say 750 gallons an hour, is going to do to that pipe. For how long do you want to put it down there? A. I am

going to put it right down, all down at the rate of 750 gallons an hour.

Q. In one hour. A. 750 gallons in the first hour, 750 gallons the second hour, and another 750 gallons in the third hour. Four hours, then?

Q. Yes, 15% hydrochloric acid. A. I can only tell you on the basis of assuming the rate of dissolving the metal is the same.

Mr. Lyon: I don't know.

Q. Do you contend these figures of yours have significance tied to oil wells? A. Yes, I think they do. I can't answer that without figuring it out. I have to assume the rate is the same as here because I have no experience with that.

Q. Do you believe it would be? A. Yes.

Q. Is it true you know of no other tests except pouring it in the tube at the rate of one gallon per minute, taking it out at the rate of a minute? A. That is the test we made.

Q. The only one? A. We made one test, one test which I described and tried to put oil in. We ran a little faster than that at the beginning but as the oil solution came out we decreased.

Q. Why didn't you try the different rates of velocity? A. First, 1¼" is the smallest tube available to be purchased; second, stoneware crocks only come in a certain size. We couldn't get more than this 250 gallon crock into the doors of our building. We figured an average acid treatment might be 300. So we put in a 200 gallon crock, 250 gallons—we could put about 200 gallons of acid in it, and if you ran a 1¼" pipe 3 hours you get 60%, approximately.

Q. You say something about an average oil well treatment? A. That is more or less hearsay in discussion with Mr. Rebbeck and others.

Q. As a matter of fact, you talked this all over with the Dow men before you ran them. A. Surely, I told you I had.

Q. They told you different ways. A. Yes, and I sug-

gested three hours. They didn't mention that. I say I said, let's take three hours, which shows this condition. We did not understand any other condition whatsoever.

Q. You understand 3 hours is the time it takes to acidize a well, to take the acid down the well and out of the pipe? A. I think that is a convenient time. I have heard of times that run over a day, much less than a day—you can't average those things. It would be trying to figure out how long it takes to shoot a duck. It may be a week and it may be a minute. You take the middle. That worked out in this 250 gallon crock which we could buy in Akron, and we started our tests and made those conditions. We made no preliminary tests whatsoever.

Q. What effect do you think it would have on your figures, any of them, if you acidized a well in the same length of time but you put about between 2500 and 3000 gallons of acid through the pipe? A. Well, it would depend on the inside surface of the pipe. Give me a specific case. I can take the average rate of attack in this tubing and figure it out for you.

Q. Do you think the rate of attack would be the same? A. I think very close to it.

Q. How do you know if you haven't tried it? A. Well, this is oil well tubing. We studied the various factors that entered in affecting the rate of attack. The figures we have obtained I think are close to what you have obtained.

Q. Does the amount of agitation have anything to do with the figures? A. I think with agitation you get a higher reduction in corrosiveness.

The Court: You don't mean that, do you? A. Higher percentage reduction in corrosiveness, for the inhibited acid. When you agitated the samples and agitated C. P. acid, the rate is increased, more attack on the steel, more attack of the C. P. acid on the steel.

The Court: The rate of corrosion is— A. (interposing): Yes. That is the C. P. acid. Now, when you take the inhibited acid and agitate it in a piece of steel, the rate

is increased, but the ratio of the two, this one, does not increase as much as the uninhibited acid.

The Court: But they each increase in corrosiveness. A. As they get higher turbulence.

The Court: By agitation. A. That is correct.

The Court: They each decrease in inhibition? A. That is correct.

Mr. Lyon: What about commercial acid? A. Because it is trying to scour off that protective coat on the surface, and keep thereby increasing the rate of attack on the metal.

Q. You have answered as to the C. P. and inhibited. What is the answer on the same point as to the commercial hydrochloric acid? A. The information we have obtained is that the commercial acid we used in our tests is not much different than the C. P. acid, and therefore there is a very low percentage difference in rate of attack.

Q. Is there any difference? A. I said up to 6½ per cent was the maximum, and most of them were zero to one or two.

Q. Well, now, you admitted that agitation is going to make a difference. A. Oh, I think it would; surely.

Q. Then there will be a difference in the amount of agitation and in the kind of agitation where you are pumping at the rate of 750 gallons an hour down a pipe or where you are pumping at the rate of 60 gallons an hour? A. Absolutely there would be a great deal.

Q. And also considerable effect on the acid. How will it affect the amount of reduction in the strength of the acid that issues from the bottom of the pipe? A. With the higher velocities I would anticipate you might get a greater rate of attack on the metal surface, but that the percentage of acid that was spent in going through, if you take a given length of pipe, it would probably be a little lower.

Q. Well, now, wait a minute. A. It would be a little lower.

Q. A litt! or a lot less. Find out how much difference do you think in the amount of corrosion, compared to your tests, would be made by this different rate of feeding

the acid through the pipe? Do you think it would double the corrosiveness or add two hundred per cent to it? A. I don't know. I really don't know. I haven't studied the velocity effects, and I am just—in the laboratory tests we ran without any agitation we got about five or ten per cent less inhibition than we got in running it at a foot per second, but I don't think you could keep on adding ten per cent for every foot per second velocity added, because pretty soon you would be over 100 per cent. I think it tapers off.

Q. You don't know where? A. I don't know where it tapers off; we haven't made any tests.

Q. In other words, is there something about the making of the—or the effect on the strength of the acid that would be brought about by running down 750 gallons of acid in the same length of time you ran down 60? That is a completely different order of magnitude than any differences due to the agitation, you can see that. A. Well, as I said before, if you started out with fifteen per cent acid in a given piece of tubing, and a given length of tubing, and ran that fifteen per cent acid through at the rate of 750 gallons per minute, you would get some reduction in the acidity. What it is I won't say. But if you ran it through at the rate of 250 gallons per minute, you would probably get a greater reduction in acidity, you see.

Q. You don't want to say what the comparative magnitudes of those would be? A. I could figure it out, if you would let me use those figures, the average rate of solution of the pipe.

Q. No. A. I have to have something to start with. I have to have some numbers. I can't express it in terms of acts.

Q. That would be, such a figure, just figuring. A. I can't.

Q. I want to get an answer that adds some facts to the case. Well, now, you were going to, I believe that I indicated I wanted you to tell me even in your tests what the percentage of concentration of the hydrochloric acid was that you recovered in your tests at the bottom of the tub-

ing. You say it was fifteen per cent hydrochloric acid at the top. A. Yes.

Q. What was it at the bottom? A. Well, in these tests, of course, which were made in this very short length of tubing as compared to an oil well tubing, the amount of iron that dissolved was about two pounds, a little over that or a little under, so take two pounds. A gallon of hydrochloric acid, if you let it spend itself on iron, will react with just about one pound of iron. One gallon of fifteen per cent hydrochloric acid. And therefore we ran through about 180 gallons of acid and two gallons out of that was expended in attacking the tubing. Now, if we have a tubing 5,000 feet long, we would have fifty times that amount, or fifty times two gallons would be 100 gallons, approximately.

Q. I am not asking that. I am asking what was the actual reduction from fifteen per cent in the actual tests that you made? A. That would be two gallons of 180 were consumed, and that is a little over one per cent, so a little over one per cent of the acid would have been consumed in that short length of tubing. The acid would have fallen off from 15 per cent down to about 14.84.

The Court: You are asking really for a qualitative analysis, I take it. A. We didn't analyze it.

The Court: He figured how much iron he got and how much hydrochloric acid would take that off.

Mr. Lyon: That is satisfactory to me. But it reduces it in the strength.

The Court: I don't know whether there would be a way of making that qualitative or not. A. There would.

The Court: That would be the effect.

Mr. Lyon: Yes.

The Court: I don't know whether it would come out by the same balance or not. A. I think you will admit the method—your men will admit the method of calculation.

Mr. Lyon: I am not asking you that. The difference between the strength of the acid as you put it in at the top of the well, and as you take it out at the bottom, with the raw commercial acid down your pipe, was a difference be-

tween 15 per cent and 14.83 per cent. A. As I explained to you the length of tubing was 100 feet long. If you did that to one that was several thousand feet long, you would have twenty, forty, or fifty times that amount of reduction.

Q. I am talking about your tests.

The Court: He wants to know what it was in yours. A. Fifteen to sixteen hundredths of a per cent. If that is the question.

Q. If you had a long well, the length of the well would be a factor that would vary that, and the rate at which you pumped the acid down the well would be another factor, would it not? A. Well, why vary two variables? Why not stick with one variable? One variable is the length. Let's leave the other variables the same.

Q. If you increase the velocity of the well, that will tend—increase the velocity of the acid, that is the length of time the acid is in the pipe, a given amount, why that has the effect of reducing that difference, doesn't it? A. From all that I could tell you, or what would be, if you keep the figures the same I could tell you exactly or very close your reduction in acidity, which would be very appreciable.

Q. Well, now, I think from your calculations of the loss in 1000 feet of 2-inch tubing, 2½ inch tubing, which you said was 9.3 pounds loss—well, what would you calculate to be the depth of the corrosion of that type? A. 9.3 pounds of iron?

Q. Aren't those the figures that you gave? A. I think that is about right. It wouldn't be very much. It would be this few thousandths of an inch. I can calculate it if you want me to.

Q. It would be in the order of a thousandth of an inch? A. I don't know. It might be three or four. If you figure that it was all uniformly attacked, and there was no pitting—

Q. Just a minute. What percentage of the tubing by weight would that represent? A. I don't think it would represent a great percentage by weight, but it might make a critical effect on the strength of it.

Q. Well, that is all I want, what percentage of weight would that be, of what order? A. If you take five thousandths of an inch, and 3/16ths, you would have, oh, that would be about 1/30th, or, no—about 1/50th, something like that.

Q. Oh, let us get it more accurately than that. A. Let us take the—have you got the thickness of the 2-inch tubing that you want me to figure on?

Q. It is 6.4 pounds per foot? A. Well, I can't tell you how thick it is from that. I can't tell you how thick it is.

Q. But you know that 6.4 pounds per foot is 64,000 pounds in 1000 feet—you know that? A. Oh, yes.

Q. And you get 9.3 pounds off of it— A. If the corrosion were uniform, it would be nine sixty-four thousandths of the total weight of the pipe. No, wait a minute. You say it is 6.4 pounds per foot and 1000 feet?

Q. Yes. A. That would be 6400—it would be 9/6400. Excuse me, it would be 9/6400.

Q. That is right. Now, do you know anything about the cost of that pipe? A. I know it is pretty good steel, and in some cases they use a steel alloy.

Q. How much a pound does that pipe run, have you any idea? A. I don't know.

Q. If I told you that it is 5 cents a pound, and you say you have lost 9.3 pounds in 1000 feet in taking off this one or two or three thousandths of a foot, that would mean that you have actually lost about 45 cents worth of pipe? A. No, that is no comparison at all.

Q. By weight it is? A. Well, that is a completely fallacious argument.

Q. Well, I am asking you for the facts, not for the argument, you know. I don't think it changes the case. A. If that was 45 cents worth of pipe you asked me, and I say no.

Q. By weight, if it is 5 cents a pound? A. You don't figure a loss, a financial loss by weight.

Q. I am asking you if that isn't about 45 cents worth of pipe? A. No.

Q. By weight, if the pipe is 5 cents a pound? A. I say it is not.

Q. All right. Now, have you got the analysis for the commercial acid that you used? A. Yes.

Q. Did you make different analyses for the different shipments? A. No. We made analyses of the crock acid before each run, you see, to be sure. We did not want to analyze each carboy, so we blended the right mixture for a run and took samples of it and analyzed it to be sure that just before the run we had the right composition, so we have those figures.

Q. You have an average? A. I have figures for each run, with the exception of two runs, and we were using the same acid, the same shipment in those runs that we used in others and the analyses were coming out so uniform that those runs were not made, the analyses by per cent inhibition of each batch was run. That was the real important factor that we had in mind.

Q. Well, now, what I want to know is the amounts of copper, lead and iron in your acids? A. Which run do you want?

Q. If they are different list them for me, if you will? A. Well, run 1-A the iron was 9.3 parts per million, the lead 1.3 and the copper .21. In run 1-AA, 4 parts per million of iron, 1.1 of lead, and .02 of copper. In run 2-A, 9.3 of iron, .9 of lead, .04 of copper. In run 2-C, 6.5 parts per million of iron, .3 of a part per million of lead, .11 parts per million of copper. Run 1-B, 11.2 of iron, .9 of lead, .16 of copper. Run 2-B, 14 parts per million of iron, .4 of lead, and .09 of copper. Run 1-M, 6.6 of iron, .15 of lead and .09 of copper. 1-N, 16.7 of iron, .4 of lead, .09 copper. 2-M, 11.2 of iron, .2 of lead, .16 of copper. 2-N, 8.7 of iron, .5 of lead, and .16 of copper.

The average for the copper is about fifteen hundredths of a part per million. The average for the lead, very roughly around half a part to one part per million, and iron is around maybe eight parts per million. I haven't averaged them. I have given you a general picture and there was very little deviation.

Q. That is about one-tenth as much copper as reported in PX-161 for the acid taken from the defendant's storage tanks and about one-twentieth as much lead and about one-fourth as much iron? A. Well, now, what exhibit are you referring to?

Q. PX-161. It is my copy of Dr. Bartell's work? A. This shows .98 in Exhibit PX-161, .98 parts per million of copper and the highest figure we got was .21 in any of these commercial acids.

Q. And the highest figure Dr. Bartell reported was 1.5? A. Yes, and the lead is about ten times or fifteen times as much lead as we had and copper is about five times or so of the acid that we had here.

Q. Now, do you have any knowledge of the amounts of copper and lead and iron that are ordinarily found in hydrochloric acid, commercial raw hydrochloric acid?

Mr. Owen: May I call attention to this fact, Mr. Lyon, that this analysis is of the concentrated acid, not of the 15 per cent?

Mr. Lyon: That is right, the numbers should be divided in half. A. You should divide it half.

Q. I think you did. A. No, I didn't. The other is 15 per cent, so yours is different. The difference would not be as great. If your concentrated is .98 parts per million of copper, and if you dilute it it would come down half.

The Court: That is commercial? A. That is commercial.

Mr. Lyon: The commercial, the maximum is about 30 so it would reduce it to 15 per cent, to put in equal parts of water.

The Court: The commercial is about 70 per cent water and 30 per cent acid?

Mr. Lyon: That is right.

The Court: And when you talk about 15 per cent you just put half water to this commercial?

Mr. Lyon: That is right.

Mr. Lyon: Now, I started to ask you, have you any knowledge as to how much lead, copper and iron is usually

found in different raw commercial hydrochloric acids? A. No, I do not have such knowledge, but from the figures that I have seen from time to time on inhibition value of various commercial acids why I would say that the copper and lead content must be very low. I have seen many figures on inhibition of commercial acid.

Q. Are you familiar with the standards of the American Society for Testing Materials? A. Oh, I am not familiar on that particular subject. I know in general about them.

Q. Have you ever looked at them to see what tolerances on copper, lead and iron there are in commercial hydrochloric acid? A. I have not.

Q. Do you know whether the amount reported in PX-161 is an unusually high, unusually low or an average amount? A. I don't know.

Q. How did you come to get an acid with only a fraction of the amounts that are found in the defendant's storage samples, as reported in PX— A. (Interrupting): I can't answer that question at all.

Q. Who ordered the acid for you? A. I ordered the acid through our regular purchasing agent, I told him that I wanted regular commercial acid. The only thing that happened, we must have purchased 100 or 150 carboys—one batch of acid when we mixed it up and measured its inhibition, it was 30 per cent. That was just the commercial diluted, and we found that they had slipped in—during this last year the Grasselli Company is starting to make a special inhibited hydrochloric acid for some government work, and by mistake they had slipped in one of those carboys, and we dumped it into the tank, and noticing that the color of the tank was darker than usual, we ran the inhibition immediately before running the test, and found that it was 30 per cent. But every other carboy we bought, we put through this test, we did not throw out any of them.

Q. Well, now, do you have this handbook with you, of the testing society? A. I do not. The A. S. T. M. publishes—well, I have got a whole side of my library covered

with their publications. I do not know which one you are referring to.

Q. I want to ask you now a few questions about these tests that you made on oil? A. All right.

Q. Your tests show that the rate of corrosion of any of these acids will be reduced if the surface is oily, or has been oiled, covered with oil, isn't that correct? A. That is correct.

Q. Can you give us any idea as to the order of magnitude there of reduction in corrosiveness? A. The figures that I gave you were, when we immersed the same article, put it over again into our acid, it was 12.1 per cent, in straight acids, 15 per cent commercial acid. When we put 2 per cent of oil in with the acid, and shook it up, and then put our sepecimen in, the inhibition was 20.4 per cent. Can you interpret those results as to what will be the effect in the acidizing of a well, or running or pumping oil down a well ahead of the acid? A. Well, it would be indicative that you would get some inhibition due to the oil.

Q. You could not say from your tests how much that would be? A. I think in this particular case, in this oil from the Zahn well, which seemed to be very high in sulphur, according to the odor of it, at least, it had a much stronger odor than any of the Michigan crudes that I have ever smelled—with that you would get something like 10 to 20 per cent inhibition, and you would get that on top of the inhibition due to the metals.

Q. Now, of course, that effect of—that measurement that you got there is based on this burnished tubing of yours, that had been especially prepared and cleaned for the test; that is true, isn't it? A. Well, the metal was bright. I wouldn't say it was burnished.

Q. You run this wire on a machine, didn't you? A. It was not a real smooth surface finish. It was fairly smooth. I mean, you wouldn't tear your hand or anything. But there were plenty of points of contact on that surface that you might say could have held oil onto it.

Q. Do you think that you would fairly say that that

was true in a comparable sense to the inside of a piece of tubing that is ordinarily found in an oil well? A. Well, many oils show no inhibition, and this particular one—

Q. I was asking about the tubing. Do you think your cleaning up that tubing and scouring the tubing and treating it with the acid might have some little effect? A. It might have some little effect, but I don't think it would be appreciable.

Q. What is the condition of ordinary tubing as you find it out in an oil well, or at an oil well? A. Well, the stations I have seen, as I say, had a little rust and a little dark colored rust, and usually some oily film possibly on it.

Q. We are talking about the inside. A. Yes. I think that is the usual condition of it. Dark colored. In some cases it is fairly clean and in other cases it isn't so clean.

Q. As I understand, you don't have the weight of that tubing that you employed, per foot, in your tests? A. Yes; I gave you the figure, 2.4 pounds per foot.

Q. Is that the weight? A. Yes. I gave you that.

Q. Well, have you given me the percentage loss in weight that is represented by the figures that you have expressed in grams per hundred feet of tubing? A. Well, if it is 2.4 pounds per foot of tubing, and the tubing is 100 feet long, it is about 240 or 250 pounds. And dissolving two pounds or a little more off it, that is two pounds out of 240 or 250, that is a little less than one per cent.

Q. Well, as a matter of fact no experiment of yours consumed as must as one per cent of the tubing, did it? A. Well, let's see. We came awfully close on one of the tests, to one per cent. Very close. I think it was 1043 grams or 1050, something like that. And that is practically one per cent.

Q. That is the highest? A. That was the highest. And the lowest was down about eight or nine tenths of a per cent.

Q. Have you given us the average rate of penetration

of the tubing by the commercial acid, the raw commercial acid? A. You mean how many inches it ate back into the—

Q. (Interposing): Well, how much of a fraction of an inch it ate back. I figured it out here as .00039 inches per hour. You think that is right? A. If you figure down to an hour, you might get a low number like that.

Mr. Owen: Better figure it, Doctor. A. Well, I will.

Mr. Lyon: .00039 is what we figured from your data. A. Well, I have to get the inside diameter of this tubing. I don't recall it offhand. And the specific gravity of steel, and so forth. I don't have those figures here.

Mr. Owen: Perhaps Mr. Lyon can give them to you. A. The inside diameter of inch and a quarter tubing. Have you got it?

Q. (By Mr. Lyon): The outside diameter is 1.66 and the inside is 1.38. A. And the specific gravity of steel?

Mr. Lyon: 7.8. A. The figure I get for the thickness of iron dissolved is about .00044.

Q. My associates here seem to take considerable exception to your statement that an ordinary chemist could have calculated the effect of this lead in the tank and they want me to ask you some more about that. A. I have indicated, in discussing Menaul—you asked me if there was any merit of invention in the thing, and I said that there was some possibly.

Mr. Lyon: My associates are pacified by the witness's last statement that he acknowledges that Mr. Menaul made something of a discovery. A. I think there was some element in there. I wouldn't say that it was real obvious. I think that there was some little element to protect the storage tank there.

Q. Now, coming back to the tank and the source of this copper, do you think any of the copper comes from the walls of the tank? A. I believe so.

Q. Ordinary steel would have copper in it? A. Some little copper in it.

Q. When you get down to talking about one or two parts per million, it has got to be pretty pure not to have

it? A. These ordinary steel tanks are not usually used to carry hydrochloric acid in.

Q. Don't you believe if anyone attempted to transport commercial hydrochloric acid out to a well in a steel tank, by the time they got there in an ordinary case they would have as many as two parts of copper per million in the acid? A. I don't know. They might have. It would depend on what kind of steel they use, and the rate of attack, which I can't tell you.

Q. How much copper does ordinary steel have, the kind of steel you make an oil tank out of? A. As I recall, that is quite variable. It may run a couple hundredths of a per cent or maybe run higher.

Q. Now, I think you said there was how much copper in the lead of this lead plate that you bought or used? A. I have an analysis of that lead, if you want the exact percentage of copper?

Q. Yes, I do. A. Around five hundredths or six hundredths.

Q. You better look at it and be sure of that? A. Mr. Lightfoot, do I have that sheet up here? I don't know that I have. It met the specifications of chemical sheet lead, I know that. This analysis shows .063 per cent copper.

Q. What do you mean, it met the specifications? A. From the A. S. T. M. We received a letter from Mr. Rebbeck or someone, the information that this was chemical lead, and he gave us the specifications, and we looked it up in this A. S. T. M. book of specifications for lead and for chemical lead the copper maximum is .08 and the minimum is .04, and this sample was .063, so it came in about the middle. The rest of the elements are listed here.

Q. Iron and lead and copper? A. Iron, lead, copper; they are not listed, no. The metals listed here are bismuth, maximum of .005 per cent. Iron, a maximum of .002 per cent. Zinc, a maximum of .001 per cent. Arsenic, antimony and tin together, a maximum of .002 per cent. Copper, I gave you the upper and lower limit. Silver—

Q. That copper is .08 per cent? A. Yes. And silver,

a minimum of .002 per cent, and a maximum of .020 per cent. Now, you asked me a question as to whether there were any specifications on leads that were commercially available that had no copper in them, and here is one that is called corroding lead, and I am quite sure that is very low cost. I am sure that is used to make white lead, and that white lead sells at a very low price.

Q. Is that the kind of lead you would have in this sheet that you put in the tank, or is that a powder? A. I think you can get lead in any form you want. The copper maximum is .0015 per cent, for this corroding lead. That is where I got the idea it was a commercial lead that was very low in copper.

Q. What is meant by chemical lead? Does that mean the kind of lead where you use it for chemical operations, where they want a relatively pure lead? A. I don't know exactly. I think probably it is but I am not sure.

Mr. Allen Owen: May I call the witness' attention to the fact that there is a note at the bottom of the page describing those leads. A. Oh, yes. Corroding lead is a designation that has been used for many years in the trade to describe lead which has been refined to a high degree of purity. Chemical lead has been used for many years and it is a de-silverized lead. Acid lead is made by adding copper to fully refined lead.

Q. And you are willing to accept the view that the kind of lead plate that you employed in your operation did not constitute a deliberate attempt to add copper to the acid? A. I don't want to go into motives. I couldn't tell you motives. I don't know. The fellows looked pretty honest to me.

Q. If you had been interested in this system five or six years ago and hadn't known that this copper had any effect at all, you would have purchased this same kind of lead, would you not? A. I don't know. I don't know.

Q. Were you the one that discovered that this lead—this copper in the lead was the bad actor, or the infringer in this operation, or did somebody tell you about it before

you went to work on it? A. I had heard it, as I said before, I had heard almost from the time of the Grebe-Sanford invention that copper was an inhibitor for hydrochloric acid, and when I saw these analyses that Dr. Bartell made, that was the one possibility.

Q. You recognized it as a possibility then. You had to go to work on it to check it and see? A. Well, if I knew copper was an inhibitor and it was present in this acid, why the logical thing was that it was an inhibitor in the acid.

Q. In what form was copper used there by Grebe and Sanford as an inhibitor? A. I couldn't tell you that. I said my recollection was very vague; that I knew copper was an inhibitor and knew that general statement, but I couldn't tell you the amounts or form or anything else. I knew copper was an inhibitor and I can produce documents to show that.

Q. Let us have them. A. I am going to do that. I can't do it right now, sir.

The Court: Does it show what copper does? A. It plates out and the hydrogen that is plated out with the copper is held on tight by the few molecules of copper that are plated out.

The Court: Is there any kind of inhibition, except that kind that puts something on the iron to prevent the hydrochloric acid from eating it? Is there any other kind of inhibition? A. I think when you get down to the fundamentals there is no other kind.

The Court: We had some talk earlier here about two kinds of inhibition, one of the kind I have described, and the other one which in some way pulled the teeth out of the acid, so that it could not bite, but I have not heard in all of the testimony any description of that, or any formula for it.

Mr. Lyon: I tried to get into that a little while ago, but I did not get very far. A. It is my belief that all of them act by forming some film. I believe that the thing that stops corrosion is the film, a film of some kind. It may

be started by some electrical action, as they claim practically happens in their truck tank, but—

The Court: Well, I will take that until somebody else claims to the contrary to know about it. Let it go at that.

Mr. Lyon: Well, now, it looks from your figures as if the copper was accumulating in the acid in the tank, in the Menaul operation, faster than the lead was, in the proportion that you have found the copper and lead. Did you notice that? A. That is correct.

Q. Can you explain that? A. Yes, because the lead in corroding forms lead chloride, which is relatively slightly soluble, some of that dissolves in the acid; but the copper when it dissolves, it forms a very soluble compound, and it goes into solution; but to get the lead which has corroded from the sheet of lead into the solution, you have to use a tremendous amount of agitation, and that is a film of lead chloride over the surface, and that is why the copper is in greater proportion than the lead.

Q. Is your statement that the copper plates out based on an actual proven experiment, or is that your opinion of it? A. That is my opinion, and the opinion is based upon the fact that if you put this copper in—without copper in solution, you have your hydrogen plating out on the cathodic parts—when you put your copper in your hydrogen goes out and forms this film, and the only way that you can get that polarized film of hydrogen is to have your surface altered, and the only way it can be altered is by plating out the metal in solution.

Q. It can't both be plated out and stay in this solution in the soluble form that you have described here. Which does it tend to do? A. It dissolves from the lead and plates out on the iron, a small amount of the copper plates out on the iron.

Q. Have you ever actually found that on iron? A. No. I say, there is just a molecule here, and a molecule there, but if you have got to explain the altering of that surface, the formation of a polarized film on there, the only way that you can explain it is by having a minute

amount of copper plating out of the solution on to those parts.

Q. Doesn't the lead tend to affect the surface as described in the Menaul patent? A. Yes, with the lead plating out, you get that lower voltage helping to plate out the copper on to the iron, but it is not very great.

Q. Is that tending to plate out the copper—is the lead helping to plate out the copper, or the copper helping to plate out the lead? A. Oh, no. I would say the lead has some very slight effect in helping to plate out both copper and lead, but it isn't very much, it hasn't enough voltage. There isn't enough voltage to plate a continuous film of either one of them.

Q. Well, isn't it true that according to your figures there is 16 times as much copper accumulated in the acid as there is lead on the basis of the portion of copper that you say existed in the lead? A. I would have to do a lot of calculating to answer that question. I will state right here the amount of copper increase in the solution is considerably greater than the lead that goes into solution, several times, probably. I have stated some of that copper undoubtedly comes from the tank. Just how much, I don't know.

Q. As I understand your statement, you were the one that first suggested to the Dow Company that the thing to emphasize in this case was this presence and action of 3 parts per million of copper, is that correct? A. No, that isn't right.

Q. I said "I understood." I ask you for the fact. Were you the first one to develop this theory? A. No, I don't believe so.

Q. Who told it to you first? A. I don't recall. I have had many talks with Mr. Chamberlain and Mr. Rebbeck and the thing evolved.

Q. Did you have this theory when you started to work on the case ? A. I had talked to these men even before we started to work. It wasn't a gradual thing that they came up to me one day and said: "Here is a bill of goods. You

do that." You talked generally about the thing, and when we got to a certain point we began to do the work.

Q. You say "gradually evolved." What evolved? A. Discussion. When we saw Dr. Bartell's figures, they came up in the discussion. I don't know who had the idea. I had heard discussed this copper is an inhibitor.

Q. This theory copper is an inhibitor is an evolution of discussion and development of a proposition as you went along in these experiments, is that right? A. The first time I ever heard of the Menaul process was in a discussion I had—I don't recall with whom but someone in Dowell, and it was the same conclusion we have now reached, that the Menaul patent was a front, a method of getting inhibitor into the acid, in order to practice the Grebe-Sanford patent, and I have never changed that idea since then while we have gone along.

The Court: Did the lead do it? A. I don't think we had analyses to prove it. Possibly the lead did, or something in the lead sheet. We couldn't tell but we felt they were dumping in inhibitor to help the thing out. That is the thought that came out in everyone's mind. I never have heard that thought resulting in proof; it was a developed process.

The Witness: Did you want this publication on copper inhibitors? You asked me for that.

Mr. Lyon: Yes. Whatever you have got. A. Here is one reference that they dug up for me here some place. Should I read it?

Q. If you can. What is the reference? A. It is from the Automotive Industries, December 5, 1918. And reading the quotation—"Tin and copper salts are representative of the inorganic type of semi-collodial inhibitors." And the article is on the chemistry of pickling baths, which is a —in which inhibitors or the development of inhibitors was quite an important thing.

Q. Would you say that that article represented the regular view prior to Menaul's invention? Wasn't there a great deal of literature in connection with electro-chemistry

to the effect that copper increased corrosion? A. I wouldn't admit that. I don't think that is the case. I can't give you any definite proof as to what the general knowledge was or anything else, but when people publish material like that, why, it indicates that somebody found that copper was a pretty good inhibitor.

Q. Does that say for hydrochloric acid? A. I think it said pickling solutions, and I don't know what acid—usually sulphuric acid, but usually in the inhibitor art if they are fairly good for sulphuric they are pretty good for hydrochloric, as a rule. There is no exact correlation. I think I have lost my place.

Q. Is that the best article that these folks can— A. (Interposing): I asked Mr. Rebbeck here a minute ago, and he just gave me the one. In my general reading on the subject of electro-chemistry and inhibition, why, I am quite sure I ran across the mention, and I can't say how many times, but it is a typical illustration of what is in the literature.

Q. Now, you tell me what just adding copper indiscriminately as copper to one of these baths would do to a steel tank, or steel car? A. Well, I would say that there undoubtedly is some optimum composition or concentration of copper for each different acid solution and so forth that gives you the best results, and if you exceed that you might get a continuous, complete coating of copper deposit, or it might be loose, and it might cause detrimental effects. I will grant to you that if you exceed a certain concentration of copper in solution that you probably would get some detrimental effects and it would not be an inhibitor.

Q. Well, that is the point. And do you know of anything in the art that taught, prior to your work on this case, that these minute amounts of copper which you are now talking about down to not more than five parts per million had this effect that you have shown here? A. Well, it is true for every inhibitor, that if you add an increasing amount of inhibitor you get generally increasing inhibition, and there are some of them you go up over a

hump, and then down. But to try to find that hump is hardly an invention.

Q. Well, I am not asking you that. I am asking you if there is any public disclosures of the fact that we have here in this case? A. Of adding it to hydrochloric acid?

Q. Yes, prior to your work on this case? A. I don't think so. But the fact that copper was used to inhibit acids, it is just like telling somebody to put some salt in some food. Well, you put different amounts of salt in different kinds of food for different people. You put the right amount in to make it taste right. So you put the right amount of inhibitor in your hydrochloric acid to make it do the job.

Q. Would you have known from this manual that you have just had read here how much copper to put in to do the job? A. No, but I would have turned it over to a very inexperienced individual that would have tried it, knowing that it was an inhibitor, having been told that it was an inhibitor, he would try the different concentrations and find the correct concentration.

Q. Did you every talk with Mr. Rebbeck or Dr. Grebe, or anyone in the Dow organization, as to what he had in mind in the statement in the patent in suit, No. 1,877,504, commencing at line 75, on page 1, where he calls for adding a small amount of a substance capable of inhibiting attack of the acid upon metal surfaces, e. g. of iron or steel, copper, etc.? A. I would like to read the language of the patent. The statement is, (reading): "To the acid we add a small amount of a substance capable of inhibiting attack of the acid upon metal surfaces, e. g. of iron or steel, copper, etc., with which it comes in contact."

In other words, you put some material, a small—a relatively small amount into an acid, that will slow up the rate of attack of that acid upon the metal surfaces that it comes in contact with. Now, in an oil well, that is usually steel.

Q. Well, now, in the Menaul system, is there anything added to the acid that inhibits its attack upon a metal surface, if that metal surface is copper? A. I don't know. I haven't made any tests.

Q. You know, don't you, that the presence of this copper is due to some action of the acid, in the Menaul process? Didn't you tell us that some of this copper could have come from bronze or a copper pump or fitting in the system? A. Yes.

Q. That would be because the acid would attack the copper, isn't that true? A. It would attack copper alloys. It might not necessarily mean that it would attack copper. I don't think the patent implied that it would inhibit the attack on all metals, just the metals that it encountered in the well. For example, if the well was iron or steel, it inhibited iron or steel.

The Court: And if it was copper, it would too. A. Well, if there was copper in the well, it would, if you had an inhibitor that would inhibit it if it was attacking copper, yes.

Q. The claims in this patent are not limited to steel or iron but to include acid upon metals, you have noticed that, haven't you? A. But if you have a well with all steel equipment, then the patent teaches, in my opinion, that you add an inhibitor that inhibits the action of acid on the steel. If you have a well that has a different metal in it to contact the acid, then you add an inhibitor to inhibit the action on the other metal, copper, for instance. If you have a mixture you try to get an inhibitor that will do a good job on either one of them.

Q. The point is nothing in the Menaul system includes any adding to the acid of a substance capable of inhibiting the attack of acid upon copper. You agree to that, do you? A. I do not agree to that, because I cannot answer the question. I cannot tell you whether the lead and copper in solution in the Menaul acid will inhibit the attack on pure copper. If you take raw acid and you take a brass valve or some alloy like that, I believe you would get some copper going into solution. I don't know what would happen after that. I do not know whether it would attack the brass or the bronze or pure copper.

The Court: I am wondering if I get into this dilemma,

that if I did not put in anything—if they would both be there, copper and iron, and I didn't put anything in, to inhibit its attacking the copper, then it would attack the copper and make an inhibitor for the iron, and I would be in a mess. Supposing it has got copper and iron and I use pure acid, am I liable, is it chemically possible here that that acid would get busy in the copper and get enough of that little bit of copper out so that it will make an inhibitor down in there against the iron? A. I would say that if the acid contained sufficient copper, no matter where it came from, sufficient lead no matter where it came from, sufficient inhibitor of any kind no matter where it came from, except from the Menaul practice of commercial acid, in other words, if those things were added extraneous, I mean it went into the well, the top of the well, if you took and pumped that acid through a two inch copper pipe one hundred feet long, in order to get copper into it before it goes into the well, I would say that would inhibit the inhibiting acid going into the well.

The Court: It goes right down. A. Supposing down at the bottom, if that is normal construction in an oil well, which I doubt very much—I am not enough of an oil well man to tell you—if it is normal construction to use brass parts at the bottom of the well—I know it is not all the way up between the top and the bottom—if that is normal construction, you get some inhibition and I would say that probably is perfectly all right, because your acid has gone into the well uninhibited.

The Court: Now, you are answering a legal question. What I was really starting to ask you was the chemical question as to whether or not if there was copper down at the bottom of that well whether you wouldn't make the acid —whether you wouldn't get enough of that copper off so that it would make a practical inhibitor? A. It would depend on how much contact it got with that metal, but the acid in going by that would be leaving the metal sysem of the well and going out into the formation so you would have no effect.

The Court: Can you tell me how much the surface of the copper would bear to the amount of the surface of the iron to do the trick? A. I can't tell you that. I think it would have to be a fairly appreciable surface.

Mr. Lyon: Will you tell us what happened in the Frasch patent? A. I have not looked at it recently.

Q. He says there he can use a lead-lined tube in his well to put his acid in. If he used a lead-lined tube, what would happen? A. The acid would start into the well uninhibited. By the time it got to the bottom it would probably be somewhat inhibited, but again the inhibition would be completed when it got to the bottom of the well.

Q. Well, now, you have described the fact that this copper is in the lead. It is there as the metal copper in the lead, isn't it? A. That is right.

Q. When this plate is put into the tank. Now, it gets into the acid by being dissolved and forming copper chloride, doesn't it? A. Yes.

Q. Isn't that the way acid corrodes a metal surface, by dissolving material off of the metal surface to form a chloride? A. Oh, yes; that is the usual way.

Q. Then, as a matter of fact, all the copper that you found in this acid got there because of the process corresponding to corrosion, that is, dissolving the metal off of a surface? A. Off the lead or out of the steel tank, or in some way it got in there, and in a truck tank there are usually brass valves or some bronze equipment.

Q. Now, you said a while ago that copper is an inhibitor for sulphuric acid. Did you mean to say that? A. I say that it is apparently an inhibitor for solutions as reported in this article. I said in general inhibitors that work in one acid—that is, sulphuric acid, are usually fairly good in sulphuric and hydrochloric. They don't necessarily have to be good in both.

Q. What about copper? A. I don't know in sulphuric acid.

Q. You don't know whether copper is an inhibitor for sulphuric acid? A. I don't know.

Q. You read this article and it doesn't tell you what acid the copper is an inhibitor for, and you don't know whether it is an inhibitor for sulphuric. Now, did you know anything about whether copper was an inhibitor for hydrochloric acid before you started on this case? A. I very definitely did. That article talks about pickling. Pickling itself, done with several kinds of acid, usually sulphuric or hydrochloric. When they say it is an inhibitor I take their word it is an inhibitor. If I read that article in 1918 (I may have seen it—I don't believe I did) it made a mental impression on my mind copper was an inhibitor for non-oxidizing acids.

Q. You made a mental note of this article this afternoon but you don't know now whether it is an inhibitor for sulphuric acid or not. A. I will say from what I read (I can't say from my own experience—I haven't made any tests) but from my reading and understanding it was an inhibitor for the acids, hydrochloric and sulphuric acid used in the pickling art.

The Court: From reading that article, so far as your getting any information, copper would be an inhibitant for hydrochloric, it would be the same for copper as it would be an inhibitor for sulphuric. A. Yes, from the article. But by my own experience I have not run any tests nor could I possibly tell from my readings, and so forth. I would come to the conclusion not from any tests I have made. I have not made any tests for sulphuric acid.

Q. You said copper was an inhibitor because you read one article. Now, you have read this article this afternoon. Do you know whether copper is an inhibitor for hydrochloric—for sulphuric acid? A. There are different ways of reading things. You read it, get a picture, draw a conclusion that is a correct statement. Sometimes you don't perform the work yourself to verify it. You couldn't. So, part of my experience is based upon what I have read, picking up on reading of other people's work.

The Court: What I understand from your remarks is if teaching prior to your experiments that copper was an

inhibitant for hydrochloric acid, why doesn't it teach today that copper is an inhibitant for hydrochloric acid and for sulphuric acid? A. Well, I think it does.

Mr. Lyon: And you think you know copper is an inhibitant for sulphuric acid? A. I will say that there is probably some concentration, sulphur salt, salt compounds, that will inhibit sulphuric acid to some degree.

Q. According to your statement there was one part of copper to 1600 parts of lead, as I understood one of your previous statements, that is correct isn't it? A. One part of copper to 1600 of lead is correct.

Q. And in these samples of the acid that you analyzed from the Menaul tank after the acid had been in there for six or seven hours, you found one part of copper for 100 parts of lead, didn't you? A. I think something like that.

Q. Now, you have suggested that the reason for that copper increasing 16 fold is that lead chloride wasn't as soluble as the copper chloride, is that correct? A. I assume that we would be correct that the ratio that you get of copper to lead in the solution cannot be figured from the analysis of a sheet of lead; that you get a higher proportion of copper going into solution. I did not say all the copper came from the lead sheet, but if you would take a piece of this lead sheet and dissolve it, convert copper to copper chloride, lead to lead chloride, and then dissolve that thoroughly in the acid solution, you would have a ratio of 1 part of copper to 1600 of lead. That is correct. Now, if you take four times as much of that sheet of lead, or three times as much, or in some number like that, and convert that by reaction with hydrochloric acid into lead chloride and copper chloride and then contact that with solution, the copper will go into solution and in my opinion the lead chloride is much more difficultly soluble, and you will have samples of lead chloride floating around which we observed. Now, that would produce a ratio of copper in solution instead of 1 to 1600 about 1 to 400. I don't know what that number is. It might be 1 to 200. Then there is some copper that comes from the steel tank, and that I don't know how much it is either.

Q. Well, now, how many parts per million of lead chloride did you find in solution in the analysis of the acids from the Menaul tank, after the six or seven— A. (Interrupting): You mean Dr. Bartell's figures, or of the figures that I made in this laboratory test?

Q. In your test you found one part of copper to one hundred parts of lead, did you not? A. We got about three or four parts per million of copper to 250 to 400 parts per million of lead chloride in solution.

Q. What is the solubility of lead chloride in hydrochloric acid 15 per cent? A. I don't know.

Q. Don't you know that it was only a small part of the lead chloride that would dissolve in the acid? A. I assume so, yes. I did not say it was saturated.

Q. Then there is plenty of room in that solution, as far as you know, for more lead chloride? A. Yes, but if you take lead chloride and you try to dissolve lead chloride in hydrochloric acid,—we have made many of these synthetic runs—in making the synthetic mixture for the running of laboratory tests, we have had to shake them for a considerable length of time, and use special pulverizing methods to bring in the crystals. The rate of solution of lead chloride is very low. I didn't say that the solution was ever saturated in those tests, but the lead crystals form on the surface of the lead sheet and then break off and float in the solution towards the bottom, some sticking on the lead sheet.

Q. Can you tell us how much of the copper that you found in your analysis of the acid from the Menaul tank, was introduced into that acid, or got into that acid from the lead plate? A. I cannot tell. I would assume that it is between one and two parts per million, maybe two.

Q. Well, can you tell? A. I cannot tell, no, because it is impossible to separate it.

Q. Did you analyze the walls of the tank? A. We analyzed the steel walls.

Q. Do you know whether it had any copper in it? A. It had copper in it, yes.

Q. Do you know in what order? A. I don't know. I think it was around two-tenths of one per cent or so.

Q. Did you analyze the oil well tubing? A. We analyzed that.

Q. Did you find any copper in that? A. As I recall, we found about three hundredths of a per cent copper in it.

Q. But you don't believe you analyzed the tank? A. I don't recall that we analyzed the tank. I think we got some general figure from the man that sold the tank. We did analyze the steel that was submitted from your headquarters as steel that went into the Halliburton tanks.

Q. Did you find any copper? A. Fourteen hundredths of one per cent.

Q. Now, did you analyze the samples that you took at the bottom of the tubing for their copper or lead content? A. I analyzed those.

Q. Where is the report on that? A. We haven't got that in the report.

Q. What did they show? A. They didn't show much of anything. They showed that the copper going in and out was substantially the same.

Q. Same amount of copper? A. There was some change in some cases, but very little.

Q. Well, enough so you consider there was any change? Would the figures be enough different so that they showed a change beyond experimental error? A. Well, some of the figures in the effluent acid that were obtained when we ran the—as I recall the blank acid tests, the copper was analyzed on small samples, and we did not feel that the accuracy was any too good. I don't recall the figures. We got about one part per million in that effluent acid, and we actually took those samples and ran inhibitions to see if we could check back and see if they were inhibited due to the copper picked up from the pipe, and as I recall it the inhibitions were very low.

Q. Now, wait a minute. Let's take the commercial acid when it was run down the pipe and you analyzed the acid samples for copper? A. When the commercial acid was run down the pipe, we ran the exit samples for copper.

Q. Did you? A. In some of the tests, I don't know.

Q. And have you got the results there? A. I don't think I have them in any report here. I think they are in those notebooks some place, that I could dig out.

Q. Well, you remember what you found? A. I don't remember.

The Court: What would you expect to find? A. We expected to find that when the acid ran through the iron tubing, which contained a trace of copper, that the effluent acid would contain some small amount of copper over what the commercial acid did.

The Court: More? It would pick up? A. Surely. Because when the steel tubing is dissolved part of the copper is dissolved.

Mr. Lyon: Did you find that? A. We found that, as I recall, that some of it did dissolve.

Q. But you don't remember how much? A. I don't remember exactly.

Q. Well, now, what did you find in the case of the acid that had been in the Menaul tank for six or seven hours? What did you find out from the exit samples of that acid as to its copper content? A. I don't recall the exact figures on that. I don't think there was much of it at all.

Q. You mean the acid coming out, the exit acid, had just about as much copper in it as when it went in? A. That is my recollection.

The Court: What would you expect on that? A. That is about what I expected. There isn't much metal dissolved in the—

Q. (By Mr. Lyon interposing): Where has all this copper gone that is going to plate and protect the tubing? A. I told you it was only an atom here and an atom there. I wouldn't expect there would be much copper used up. Just a minute amount that is going to plate.

The Court: But that is the thing that is going to stop the corroding by the acid, is the coating that goes on, as I understand. A. That is true. But you take acid with a certain copper content and run it through a pipe and it

dissolves from the surface of the pipe iron, and some small amount of copper, and you have or may have that plate on certain areas of the pipe and the copper go in solution from the pipe. I just don't know how, but the effluent may not be greatly different. It may be a minute amount different.

The Court: Why don't the—if that is all this inhibitor does, is to do that spotty job of plating, why don't the acid eat the places that are not plated and make pits? A. Well, that is the part, where it is not coated with the copper, is the part that is the pure iron, and the cell—the copper over in these other parts is putting this hydrogen layer on that and prohibits that cell from acting, the iron dissolving, and the hydrogen plating.

The Court: I am talking about the spots that are not coated. A. That is what I am saying, that in order for the iron to dissolve you have to have this electro-chemical cell to function, and some of the parts of the steel that are pure iron, that are not coated with copper, the copper coats over on the impurities and builds up this hydrogen field which prohibits that little corrosion cell from functioning, and before the iron can dissolve, although it is bare, it has to be connected in a complete electrical circuit.

The Court: Well, then, over in this pure iron place you show there is where the hydrogen is? A. Over the impurities is the hydrogen layer; the pure iron is just uncovered.

The Court: Well, why doesn't the acid bite it? A. Well, the belief is that it requires this electrochemical action for the solution to occur. You have got to have a complete electrical circuit and the motion of the ions.

The Court: In order to have the iron— A. (Interposing): Dissolve.

The Court: In order to have the acid act on the iron? A. On the iron. But the quantity of copper is very little.

The Court: You just spoil that part of the battery that you start the thing going with, the impurities. A. Yes.

CROSS EXAMINATION (Continued)

Mr. Lyon: First, Your Honor, I might state that the plaintiff delivered to us two bound books, they seem to be ledger books, which I am going to ask the witness to identify for the purpose of the record; and, in addition, they delivered to us five holders of what appear to be preliminary reports, which I am also going to have him identify, so the record will be clear. The first of these books has written on the inside front cover the following:

(Reading): "Data book Menaul test, Dow vs. Halliburton, September 1, 1939, C. F. Prutton."

Mr. Lyon: Dr. Prutton, can you tell us what this book is? A. That book contains the data that were taken during the work on these tests that have been reported.

The book was marked for identification DX-190.

Mr. Lyon: Is this book in your handwriting, or are the entries in this book in your handwriting, Dr. Prutton? A. Very few of them are. Various writings in this book are signed by different individuals. For instance, the first subject, commencing on page 5, and ending on page 19, is signed "William J. Lightfoot," who was one of my assistants.

Q. I notice beginning on the first page of this book, DX-190, is an index and that this index, under the description or title "Description of Run" commences with a series listed A, B, C, D and so forth, and then in the next column is what appears to be a modified or revised listing changing the numerals of the run, and then there is a third column in which there is a second revision. Can you explain that? A. No, I can't explain that. We simply ran these runs at random and they were all mixed up. The Menaul tests, and so forth. And when we came to write, to split them up and write a report on the Menaul tests separate from the report of the crock tests, why, we changed the designations of those so that they would be more in order.

Q. Well, the reports which have been offered in evi-

dence here, Exhibits PX-184 and PX-185, present the data in somewhat different recalculated form than what appears in DX-190; that is correct, isn't it? A. Yes, I think there is a little difference.

I did not personally prepare the tables that are set forth in PX-184 and PX-185. My recollection of the way in which the written text of the reports and statements contained in PX-184 and PX-185 is that I wrote it up in longhand and had Mr. Lightfoot go over it and edit it to see if it should be corrected somewhat, and then I worked over the final draft so I would say that I probably wrote it.

As to the order of the experiments recorded in DX-190 and which of those experiments or runs are reflected in PX-184 and PX-185, might I ask Mr. Lightfoot to help me with this? He kept most of the books here, and the data, and so forth.

The Court: Would you like to have him sworn? I don't care to, but they did that before. When Dr. Bartell was here, we had his associate, and as I remember they were both sworn as witnesses.

Mr. Lyon: Perfectly all right with me. I am not interested in this witness except to get the facts before Your Honor in the quickest way.

Mr. Lyon: Now, the first run recorded in DX-190 is written up commencing at page 26 of DX-190 and continuing through to page 35, and is signed by Merrill L. Reihl and is dated 11/24/39, entitled "Run No. A." Can you tell me whether or not the results of that run were reported in PX-184 or 185? A. I don't believe they appear in any of the reports. I am not sure. That was the original set of tubing that we did not use in any subsequent runs. We found out that different lengths of tubing gave different corrosion rates and therefore we picked out two subsequent sets to run the remaining tests on. That was my recollection. That was one of the first runs.

Q. Well, how do the results of that run compare with the figures that you arrived at in your conclusions in Exhibits 184 and 185? Can you state at this time? Were they higher or lower?

Mr. Lightfoot: I believe about the same.

A. I think they are the same order of magnitude. There was not a great deal of difference. As I recall, we used a 100 foot length of tubing in the run and we got a lower amount of iron dissolved.

Q. Run A commences on page 26, and after a description of the run a suitable length, it contains record of the exact determinations. It doesn't look to me as if that run is any different from others that you made. It seems to have entirely different results. A. Well, 200 gallons of acid, practically, so that it was similar to the other runs. Can you find the others for me?

Mr. Lightfoot: May I have the reports? This contains the calculations.

A. (Witness continuing): The numbers are here but you have to do a lot of calculating to get the results, make analyses, and so on.

Q. What I am trying to get at, compare these actual measurements with other measurements in DX-190 and tell me, if you can, why you discarded the work that is represented in this one run. A. I told you my general recollection was it was in the same order of magnitude and we had no similar runs to this particular tube.

Q. Let's be sure of that. I think the tubing is described on page 25 and under the title of "Equipment" item 2, "5 lengths of 1¼ C45 API external upset tube range 1000 AC 2.40 points obtained from Oil Well Supply Company. Tubes are new and have not been used." Now, aren't those the same tubes used in subsequent runs? A. According to my recollection they are not. We bought 22 tubes, as I recall, and we used each one of them. When I say we used Set No. 1 it means a certain number sequence number test. These tubes were not used, is that correct?

Mr. Lightfoot: That is correct.

(Witness continuing): In other words, we cut up tubes to make corrosion inhibition samples. The calculation on that run was 622.9 grams of iron dissolved. Now, we had other blank runs that ran 791 grams of iron dis-

solved. This was lower than the lowest of the blanks that were reported but we had no subsequent work on those tubes, that set of tubing; some of the tubes were sawed up to make fittings and to make samples, and it was on that run that we found out that different lengths of tubing would corrode at different rates, and that there was a difference between two different lengths of tubing and therefore either following that run or about the third one—I don't recall which—it is several years ago, we came to the conclusion that we had to take Tube 13, 14, 15, 16, put them all in a row in the same order and run the same tests through that tubing, give it a good cleaning after each run and then we could get comparative results.

Mr. Owen: Doctor, was this length of this tubing, this first set of tubing, the same as the later ones? A. It was somewhat shorter. I don't recall the exact length, do you?

Mr. Wiles: With different lengths of tubing you are using the 20-foot pieces? A. Yes, a 20-foot length of tubing when we ran acid through we might have 140 grams of iron dissolved from one length in the same run, and the next length might dissolve only 120 grams. There was a difference in the tubing and we determined after the first run or two that we were going to take a definite sequence of tubing and use it in a whole series of tests so that we could figure what the raw acid did on these sheet tubes, and on the same tubes after they were cleaned on the inside we would determine what the inhibited acid would do.

We would determine what it would do on the Menaul tests and without the wire, and the results we reported are the results of those tests run upon two completely separate series of tubings, and this result, if you take that even at its face value, and assume that it was cleaned out in exactly the same way, and that we ran it exactly the same as the rest, and this was the first run we made, and the men doing this cleaning operation probably had not standardized quite as well as they did on subsequent tests, and the first test that we ran, all the data is in the book there.

We did not run any preliminary tests and throw away

the data. That is the first run we tried and the results even if we take that as a blank, 622 grams dissolved. We can use that figure to compare the inhibited acid. The answer would be we get 50 per cent inhibition. In other words, the acid is still inhibited, even if you use that other low one as a blank. We have five blanks, as I figure. Four we reported and one we took as our first preliminary run. Even if we take this low one and use it as our standard reference figure for the uninhibited acid, still this acid with the lead and copper in is 50 per cent inhibited. In other words, that dissolved in the acid with lead and copper in, the amount of iron dissolved was from 100 to as much as 300 grams. It was down there less than a half as much as even this lowest blank and of course we did not incorporate it, or rather the reason we did not incorporate it was simply because we hadn't found out yet. We thought when we started out, we ordered from the Oil Well Supply Company this tubing, and we told them—I talked to whoever took the order, the sales department, and I told them I wanted to be sure I got this tubing from one mill run in order to get uniformity, and he said he couldn't guarantee that it would be from one mill run, but he was quite sure the tubes he would send us was from one run of the mill.

They buy a large amount of tubes and we thought if we got them the same we could more closely duplicate the tests we were making, and then this run, in this run we found that we got a difference between different lengths of tubing of about 20 per cent in the rate of attack of the acid, and for that reason we came back to the system figuring that we had to use the same tube and the same order and run the tests through that same tubing system.

Then to check on that we took an entirely different tubing system and run our tests. This first tubing system, in some of our preliminary work we cut some of those tubes to make elbows and to make small samples, and those tubes, I don't know whether they end, any of them ended up in the final lengths of tubing or not.

Mr. Lyon: Now, this run A commences at page 26 in

DX-190, and I would like to just have the court understand what is in DX-190 before the recording of that first run. I am correct, am I not, that following the index which covers pages 1 to 3, the next entry commences on page 5, and continues to page 19, and is signed on September 11, 1939, by William J. Lightfoot, and is entitled, "Copy of Dr. Bartell's report, dated January 20, 1939." A. That is correct.

Q. That report, before you undertook this work, you had Dr. Bartell's entire methods of analyses, the results of his analyses, in connection with iron, copper and lead, entered in your book to start with? A. I don't recall whether that was entered or not. I think there was just a copy of his report.

Q. Will you just take a look at it? (handing Exhibit DX-190 to the witness) A. As I recall, we obtained through Mr. Chamberlain one or two of Dr. Bartell's original reports, I mean, the preliminary work that he had done. In this material copied in here, it is mainly the methods for determining iron, copper and lead in minute amounts from acid solutions that I believe or understand that Dr. Bartell got through Dr. Willard, the analytical man at the University of Michigan, and which he had used, and we wanted to use the same methods. As I recall, and you might check me on this, Mr. Lightfoot, the figures that are reported here were some preliminary figures that were taken out of these very preliminary reports of Dr. Bartell, and the method for copper that is given here I think was replaced by another method that was more accurate.

Mr. Lightfoot: That is right.

A. We had trouble in getting very good checks, determinations, as I recall, using this particular method on our particular samples.

Our samples were different than Dr. Bartell's, in that there was a considerable amount of iron present, more so than in the defendant's truck samples. If you will remember the analysis, the average analysis reported by Dr. Bartell was some 400 parts per million of iron; and in the

samples we had, the iron was up around 1300, and even higher. In other words, the acid that we made in our Menaul tank had a considerably greater amount of iron, and, therefore, there was a possibility of the iron interfering to a greater degree in the analysis, and we found that we could not get extremely accurate checks with this method. That was subsequently replaced by another method of copper analysis which is shown in the report. The method of copper analysis that we used on all of the determinations is shown in our report, and I am not sure if it is in this book, or not.

Q. Well, does that first entry in DX-190, particularly insofar as it is directed to the determination of minute amounts of copper, refresh your recollection on the point which I asked about yesterday as to whether or not when this work was presented to you, or you were called upon to do this work, you received the suggestion from others that what they were interested in was establishing the effect of these minute amounts of copper? A. Well, I have told you that I had contact with this case and knew of this Halliburton procedure, and so forth, before Dr. Bartell was connected with this case, and, therefore, I am very sure that he did not tell me about the copper. I knew that copper was an inhibitor, had had general knowledge. I had seen—it is difficult for me to figure out just where I first got the information—as I recall some five or six years ago. I started to see analyses of the Halliburton acid that were run in the Dow plant, and the discussions that were had as to the validity of the method and as to how they obtained protection or inhibition, which these samples always showed. And I can't tell you exactly when I first found out that copper was present in the Menaul or the Halliburton acid samples. But I don't believe I obtained that first from Dr. Bartell. I am sure of that. But it is difficult for me to remember back.

Q. Well, you are quite sure, are you not, that before the samples were obtained from these four Michigan wells which have been reported in evidence here that the Dow

Company had obtained many samples of Halliburton acids and had analyzed the same and studied the same and you were in on some of those discussions? A. I had seen some of the tables of results of the analyses of some of the acids, and the inhibitions that had been run upon them, and I think it was probably from some of that work that I got definite information that copper was present. I think so.

Q. When was that? Have you any way of telling us when the idea first presented itself that there were minute amounts of copper in those test acids and that that should be studied to see if they were giving the inhibiting effect? A. It really is—there are so many little discussions and little mentions made of the thing, and with so many different people, that I couldn't put my finger on it. It was at least five years ago, I believe, and Dr. Bartell, I think, has been associated with the work only about two.

Q. All right. Now, just to continue with the contents of Exhibit 190, following the entry of Dr. Bartell's report which concludes on page 19, then we have on pages 20 through 21 some analytical work for determining the carbon in steel samples. A. Well, I don't know. We received, through Mr. Conner, samples of the steel which was supposed to represent the type of steel used by Halliburton in making up their truck tanks, and I turned them over to Mr. Reihl to analyze and told him I particularly wanted copper determined in them, and he went through, as you do in steel analyses, and just ran everything. He ran carbon and I think silicon and some of the other elements.

Q. The entries of those analyses cover through to the end of page 23 of DX-190, that is correct? A. I believe so.

Q. Now, on pages 24 and 25, under date of October 30, 1939, you have an entry of comparative runs to determine the corrosiveness of commercial hydrochloric acid that you purchased from the Penn Salt Manufacturing Company and the Grasselli Chemical Company; is that correct? A. I don't even recall that we had any acid from Pennsylvania Salt.

Q. Just examine that entry. A. I don't remember that. Did we buy the acid?

Mr. Lightfoot: No.

A. Where did we get it?

Mr. Lightfoot: We asked for samples.

A. We got the sample from Pennsylvania Salt Company of the acid, and samples from Grasselli and ran comparative corrosion tests and recorded them.

As to why we selected the Grasselli acid instead of the Pennsylvania Salt Company acid, I recall they were about the same, and we just took the Grasselli because it was in Cleveland and we could get the acid delivered immediately and without any trouble and we could return the carboys, and there was a lot more convenience. I don't recall why we got the Pennsylvania Salt unless somebody suggested it to me. Somebody must have suggested it to me, because I didn't definitely recall that.

Q. The next entry in DX-190 commences on page 36, entitled "Run No. B" dated December 16, 1939, and after the description of Run B and the entry of the data there is a table on pages 42 and 43 of the results. Those results were not carried forward or used in Exhibits 184 or 185. Can you tell us why? A. I cannot tell you why. The comments I have here, there was not enough data taken in the tank samples to permit making calculations.

Mr. Lyon: Look at the data and see if you can confirm that statement. A. This test was a peculiar test that I described to the court in my direct testimony, in which we tried to run the acid through this Menaul tank so fast—

Mr. Lyon (interrupting): No.

(Witness continuing): I am telling what Mr. Lightfoot tells me. Ran it through so fast without this agitation.

Q. Before you go any further on that, I call your attention under the title "Conditions of Test under 41—The rate of flow through the pipe is to be 1 gallon per minute." That is the same rate you used in the other tests. A. We ran from the crock. Let me explain we ran from the crock to the steel tank and then we gave no six-hour agitation

but ran it immediately at 1 gallon per minute through the tubing in order that there would be no time to pick up the inhibiting metals in that tank, and we would have all the conditions of the Menaul process without any metallic inhibitors in there.

Q. That is your understanding?

Mr. Lightfoot: Yes.

(Witness continuing): But when we got through we found the iron picked up from the tank the acid got richer and richer in iron and lead, that the copper went along, and the acid was fairly well inhibited due to the metals by the time it got to the pipe. Therefore, we got a combination inhibition due to the metals picked up. It was sort of an odd test that we didn't include, therefore.

Q. Under Item 8, page 37, which bears the title "Condition of Equipment" is this entry—"To polarize the steel tank before the run it was filled with 200 gallons of 15% hydrochloric commercial grade and a lead electrode was placed in the acid and a storage battery fully charged was allowed to discharge through the solution. The battery was connected so that the lead plated out on the iron tank. The time of the discharge on the battery was 24 hours, i. e. the battery was allowed to remain connected for this period." A. That is about right. That is the polarization I described in the report.

Q. Then under page 40 is a diagram of the equipment and shows the same layout as was employed in the tests that you have reported here? A. That is correct.

Q. Under the title of "Conditions of Test" on page 41 the entry reads: "15% hydrochloric acid to be passed from the stoneware crock to the steel tank and directly through the piping system. The temperature of the acid to be 85° F., the hydrogen to be vented at the T, the rate of the flow through the pipe is to be one gallon per minute, the T in tank to be connected by electrical conductor copper wire. The tubing is not to touch the tank. Just before the run the steel tank was washed with 25 gallons of 15% hydrochloric. This was syphoned off and dis-

solved," does it not? A. That is correct. To make it more intelligible you want to put the emphasis on 15% hydrochloric acid to be passed from the stoneware crock to the steel tank and directly through the piping system. In other words, without the six-hour waiting period.

Q. Now, on the next page is a tabulation and the data of this run, and the run consumed from 1:52 P. M. to 5:06 P. M., as shown by the time-table in the first column. That is correct, is it not, Doctor? A. Yes, that is what it shows there.

Q. The data in this table shows much less corrosion than in the figures that you have presented in Exhibits 184 and 185, does it not? A. That is correct, and that is due to the picking up of the metals in going through the tank, which I explained to you—

Mr. Owen (interposing): What run does that data refer to that you have just mentioned? A. It is run B in that particular designation in the book. We have not reported that, because it was a combination of—well, we got partial inhibition, due to the metals in the solution.

Mr. Owen: That was one where you ran the acid direct from the steel tank, without letting it stand in there? A. Without letting it stand. Of course, the acid was in the steel tank for three hours, some of it. In other words, we put the acid in the tank and started to discharge it at the rate of a gallon a minute, but the test lasted for three hours, and, therefore, some of the acid was in there three hours, and the average was an hour and a half, I think, in there, and it is logical to think that that would—that you would get some inhibition there. We could not figure the iron because—and that is where we found out how we had to run these Menaul tests—the iron content in the Menaul tank would increase during a run, and we were innocent enough to believe that the tank would be inhibited by this lead sheet, and that the iron content would stay constant, and we took, as I recall, one sample—

Mr. Lightfoot: Two samples.

A. — two samples out of the tank, but in later work

we took a number of samples, every twenty minutes, so that we could have the iron concentration in the Menaul tank, and as it stood in the tank, the iron concentration went up, and we had to follow that curve, we had to follow the curve of the samples very closely, and so, taking only one or two samples, we could not make any calculations of that run of any accuracy at all, and I think that was the last Menaul run that we made in which we took only one or two samples for iron.

Mr. Wiles: Doctor, when you said you showed much less corrosion than shown in your report, you mean much less than the blanks? A. It shows somewhat less than the blanks. I don't know. You couldn't figure it accurately because we didn't follow the iron content in the sample. It is just an approximation. We made some blank runs later on these two sets of tubing, which we used in our report, and those runs dissolved 800 to 1000 grams of iron, somewhere in that order. This run, taking, even if you take those few determinations of iron in the tank and tube, which we found was not sufficient to show the content of iron in the tank, and figure it, it would be somewhat less than the amount of iron that went into solution in this particular run, and we explained it by means of metals that dissolved into the acid.

Mr. Lyon: Have you any figures in connection with this run B, how much lead or copper or iron was picked up by the acid in the tank?

Mr. Lightfoot: Maybe if we can look through the book.

Q. We will have to find that our later, because we can't stop to look through this book now. Now, the next entry in this DX-190 commences at page 46 and is entitled "Run No. C, December 21, 1939," that is correct, is it not? A. I don't recall the dates or anything else.

Q. And that entry, or the data on that run covers through page 53, and is signed by Mr. Lightfoot. Can you tell me—to shorten the matter, the data on that run, which is the first run used, first run in point of time? A. Yes.

Q. Which is used in either Exhibit 184 or 185, is reported run 1-M in Exhibit 185, is it not? A. This is the Menaul test. Yes, that is correct.

Q. This run at page 46, under the title of "Conditions of equipment, item 3," reads as follows: "Tubing" is grounded at the end to a water line and insulated at all other points of support." What was the purpose of grounding the tubing at the end to a water line, do you know? A. Yes, very definitely. In a well the tubing is grounded, and we wanted to ground that particular tubing to simulate as close as we could the electrical conditions in a well. The tubing is grounded and the truck tank is not grounded, because it is usually on a truck that has rubber tires to insulate it from the ground. We supported our steel tank on dry boards, several of them, to keep them off of any conducting material, to insulate the steel tank from the ground, but the tubing was grounded.

Q. And why did you insulate the tubing at all other points of support? A. That I can't tell you, but it is immaterial so far as any electrical action is concerned.

Q. Well, it is not because that is the condition in an oil well, is it? A. I don't know why they did that. I didn't give them instructions to do that. I had told them to insulate the tank and to ground the pipe, and they probably figured, well, if he wants the pipe grounded, we will ground it, and they wanted to know where they should connect the ground wire, and I think I told them the bottom end, but the rest of it, why—

Q. (interrupting): Had you given any thought to the possible effect of grounding that pipe at the bottom and insulating it at all points with respect to the matters we were taking about yesterday as to the potential at the bottom of the pipe? A. I don't think it would make any difference.

Q. Have you considered that? A. Oh, certainly, certainly.

Q. You don't think it would make any difference? A. That is right.

Q. What about stray currents? A. Stray currents, you mean from the ground? Well, if we had stray currents that would need any protecting, or anything like that, or the reverse, we would have found them in these runs.

Q. How do you mean, we would have found them? A. We would have found the inhibiting effect, if it was an inhibiting effect, or corrosive effect, we would have found them. We wouldn't have been able to have checked within about ten per cent as we have. There would have been tremendous effects, if there was any stray currents.

Q. Did you find any? Did you test for them? A. No.

The Court: What do you mean by stray currents? A. Stray currents, if there are differences in potential in various parts of the earth, and different structures in the earth, and due to these galvanic cells, or due to the loss from power lines, and so forth, leakage occurs and there are minute currents that migrate around, but if when you have a well grounded insulation, such as a water system that has about the same potential as the earth, and there is very little chance that you are going to get any particular current, or any current flow due to stray current action.

The Court: Just where is it grounded in an oil well? A. Well, the tubing goes down through a head, and the casing is in contact with the earth and is grounded all the way down, the earth or cement, which is grounded, and the tubing is connected to the casing up near the top of the tubing.

The Court: And then the grounding to the tubing is at the top? A. Well, it is, yes.

The Court: And from the tubing this would be—this would run back up to the top and over to the casing? A. That is correct.

The Court: And then from the casing out into the earth all the way around? A. Yes, that is correct, but what we were doing—I don't feel that it makes any difference—

The Court: Is this the theory, that the tubing hangs

down into either space or into water or into oil? A. Down in the well.

The Court: And that is not grounding? A. Well, sometimes it may rest on the ground, but usually it does not.

The Court: You don't call it grounding because it touches this fluid, whatever it is—that would not be grounding? A. Well, it would be grounded somewhat if there were acid around it in between the casing and the tubing, and there would be—if there would be under certain conditions you would have a grounding effect there; but the conductivity of the steel is so great—the electric conductivity, that if you ground a piece of steel, you do not have to ground a particular corner of it. If I have a plate, or a piece of steel, and I want to ground it, I can put a wire at the plate, at any point, and the whole plate will be grounded, because of the conductivity.

The Court: The entire casing being grounded, and the casing being metally connected to the tubing, the entire tubing is grounded? A. That is correct.

Mr. Lyon: The next test, or, the next run that was made is the one recorded commencing at page 54 of PX-190, and continuing through page 61, under the title of run D, dated January 5, 1940. This run is reported in Exhibit 185, under the designation 2-N, is it not? A. That is correct, yes, sir.

Q. The next run that is reported in PX-190, commences on page 62, and continues through page 69, and is signed by Mr. Lightfoot, and is entitled "2-B, dated January 13, 1940." Now, were the results of that run reported? A. They were not reported.

Q. Were they reported in either Exhibits 184 or 185? A. They were not reported.

Q. This was a run made with the Menaul tank, was it not? A. Yes, sir.

Q. And using the same type of apparatus that is diagrammed in Exhibits 184 and 185? A. That is correct.

Q. Under page 65, under the title "Conditions of

test," it reads, (reading): "15 per cent hydrochloric acid, to be passed from stoneware crock into the steel tank, and directly through the piping system; the temperature of the acid to be 85 degrees F.; the hydrogen is to be vented at the tee. The rate of flow of the acid through the tubing is to be one gallon per minute. The tank and the tee are connected by an electrical conductor copper wire. The tubing is not to touch the tank." Is that a description of the test? A. It is similar to test B, but it was run with different tubing, however.

Q. Pages 66 and 67 show a complete table of the results of those tests? The actual measurements made? A. It shows some of the measurements.

Q. And the first column is time, and the test started at 12:42 and continued through to 10 minutes after 4:00. A. That is probably correct, if it is down there, yes.

Q. And why did you discard the results of this run, 2-B? A. Because for the same reason we discarded B. We got the same results. We got a reduction in corrosiveness and we found that was due to metals that were picked up in that short time of contact in the tank. The acid was in the tank an average of an hour and a half, as I explained before, and our analyses of the acid leaving the tank showed it had more than two parts per million of copper towards the end of the run. And the loss of iron, even so, was—the actual amount of iron dissolved was 490 grams. It was right in between the blanks and the ones made with the Menaul process proper.

Q. Now, I will try to speed this up. The next run that appears in PX-190, in order, was dated February 5, 1940; and is run A and is reported between pages 70 and 77, and that is the run referred to in Exhibit PX-184 as Run 1-AA, is it not? A. That is correct.

Q. And the tubing used in that run was the tubing used in Run No. C? A. In Run C, that is correct.

The Court: Read to me what he says about the description of the test, like you did in the other.

Mr. Lyon: Conditions of Test, page 73: "Fifteen per

cent hydrochloric acid to be passed through the tubing system from the stone crock. Rate to be 1 gallon per minute. Temperature 85° F. The acid contains no added inhibitors." This was a test without the steel tank.

The Court: Will you read it back. I am sorry to bother here, but back in 2-N, what does it say back there about it?

Mr. Lyon: I think page 57 is what I should read in response to Your Honor's question, instead of page 65. This is 2-N. Conditions of Test: "Fifteen per cent hydrochloric acid to be passed into the steel tank and to remain in the tank for six hours with mild agitation."

The Court: I think I find the same thing on 1-M, probably; is that right?

Mr. Lyon: I think so. I will try to find it for you. Conditions in test of 1-M are reported on page 49 and read "15% hydrochloric to be passed into steel tank and to remain in tank for six hours with agitation."

The Court: That's all. You have answered my curiosity.

Mr. Lyon: Now, the next test in order is dated March 17, 1940, entitled "Run F" recorded in PX-190 commencing at page 78 and through page 95 and is referred to in exhibit PX-184 under the two designations of 1B, is it not? A. F is 1B in the report.

Q. The conditions in that test as stated on page 81 are as follows: "15% hydrochloric acid containing $PbCl_2$ $CuCl_2$ $FeCl_2$ so that concentration is similar to that obtained in run C after acid had stood in the tank for over six hours, to be passed directly from the stoneware crock to the tubing system. The tubing was that originally used in C. The temperature is to be 85° F and the rate 1 gallon per minute." A. That is correct. That was a synthetic mixture we ran directly from the stone crock.

The Court: That was run directly and was discarded? A. No, sir.

Q. We have two exhibits, PX-184 which I understand has no Menaul tank runs, all just runs from the stone

crock into the tubing, and PX-185, which reports the runs through the tank.

The Court: Is this right from the crock to the tubing? A. Yes, sir. The synthetic acid to which we had added the metals.

Q. Through each of these runs where there is a Menaul tank we found this same statement—that the tubing was grounded at the exit end, insulated at all other points. A. That is true in all the runs.

Q. The next run is dated April 6, 1940, and is entitled in Exhibit DX-190 Run G, pages 86 to 93, and that run is referred to as 1A in PX 184, is that correct? A. That is correct. That is another stoneware to tubing run.

The Court: Crock to the tubing?

Mr. Lyon: Yes, sir. The next run reported in DX 190, pages 94 to 101, as run H, dated April 13, 1940. The conditions of test of this run as reported on page 97 read as follows: "15% hydrochloric acid would be passed into the steel tank and to remain there for six hours with mild agitation. Then to be run through the tubing system at 1 gallon per minute at 95° F., the hydrogen to be vented at the tank and the T to be connected by an outside electrical connector. Tubing is not to touch the tank." There is a table and the results of that test on pages 98 to 99, and that test is referred to in Exhibit PX-185 under the designation 2M? A. That is correct.

Q. The next reported test in DX-190 commences at page 102 and continues through page 102 and continues through page 109, dated April 18, 1940, entitled "Run I." The conditions of that test as given on page 105 are as follows: "15% hydrochloric acid containing $PbCl_2$ $CuCl_2$ $FeCl_2$—so that the composition of the acid is similar to that in Run H—after the acid had remained in the tank for seven hours, the acid to be passed directly from the stoneware crock through the tubing system. * * *" A. This is the synthetic mixture with the acids introduced, run directly from the crock to the tubing.

The Court: They are doing in the crock what they contend has happened in the transportation tank?

Mr. Lyon: That is correct. "The acid to be passed directly from the stoneware crock through the tubing system. The tubing used was that previously used in D and H, the temperature to be 85° F., and the rate of the acid through the tubing 1 gallon per minute." There is a table of these results on pages 106, 107, signed by Mr. Lightfoot, and I will ask you whether these results were reported or given effect either in Exhibits PX-184 or 185? A. They were not.

Q. Why not? A. Well, the first thing when we completed the test and had our analytical work completed, which was some time after the test had been completed, we found that there was considerable discrepancy in the copper content of the inlet acid which was, as I recall, pretty close to 3 or 4 parts per million, but the exit acid analyzed (and we had a number of analyses on the exit acid) showed a figure of about 1½ or a figure of that order. Then we had run inhibition on the inlet acid and it ran very much lower. In the laboratory inhibition test no acid with that amount of copper was run. We didn't have enough sample left of this particular run to reanalyze and redetermine the inlet copper. The only thing that we could see was that something had happened in there that the weighing out of the copper salt or something that had produced some peculiar effect and we dropped that one out. We did not have enough.

The Court: It did show less copper than the other? A. Yes. The exit acid from the tubing was very low, but the inlet acid analysis that we ran, the first one showed it to be high, three or four parts per million, as I recall, and the inhibition that we ran on the inlet acid—we ran it in the laboratory test—was about half of what we got on other samples that had the three or four parts per million of copper and lead in it; and, therefore, we believed that for some unknown reason the copper content of the acid was not correct, and not having enough samples to go back and run the inlet acid over again, we decided that we would not report that result.

Mr. Lyon: How about the actual amounts of corrosion, the dissolved metals, as reported in the different measurements in this test, compared with other tests? A. I believe the corrosiveness was fairly high. It was about—

Q. Will you examine this and see (indicating)? A. I cannot tell from the figures. You have got to calculate it. You have got to take all these figures and make your calculation. You remember about what it was, Bill? Was it 500 grams, or something like that?

Mr. Lightfoot: I don't know, but I can calculate it.

Mr. Lyon: Was it lower or higher than other tests? A. I don't know. I don't remember.

The Court: Let me ask you this question, if all your tests had been comparable to this, and had run like this, would the results have been more favorable to Halliburton and less favorable to Dow? A. It would be more favorable, definitely to Halliburton, but still that wouldn't change the degree, it wouldn't change the picture, but—

The Court: I just want to get it squarely on the record, and in my head, that these were some results that would have been more favorable to the other side, if correct? A. If correct, yes, and we have all the figures there that they can see.

The Court: How much more so, speaking generally? A. Well, that I cannot tell unless we have got all of the figures.

Mr. Lightfoot: The iron was in the 400's.

Mr. Lyon: As compared with 1000 for the other tests you reported? A. The blank was 1000, the uninhibited acid, and this acid which was made up to duplicate some of these tank truck acids with lead and copper ran about 400, or maybe between 400 and 500, according to Mr. Lightfoot, instead of two to three hundred that we reported on the other figures. In other words, instead of an inhibition of 70 to 80 per cent, it would have been 60 per cent, and we had an explanation for that drop.

The Court: Now, let me ask you this question: What do you think if this had been, this one, had been as much

more favorable to Dow and unfavorable to Halliburton as it was favorable, do you think you would have discarded it entirely under all of the circumstances, or do you think you would have reported it for whatever it was worth, what do you think about that?

Mr. Lyon: I would ask him to remember run 2-A which said report shows about the same amount out of line in favor of Dow, when he answers that question. A. Well, I think that this is further out of line than any of the things reported, and some of the others are out of line, I will grant you that, and regardless of the—when you look over a series of data, if you see one of them more out of line than others, I think you are permitted to drop that, particularly if it doesn't change the over-all picture.

The Court: Is this more out of line in favor of Halliburton than some of those recorded, I mean the others recorded are out of line the other way? A. Well, as I recall this is more out of line. And you can't—you have to look at a whole series of numbers to figure out whether it is out of line or not, and it is difficult to put your finger over one definite thing and say that that is the thing that determines whether it is out of line.

The Court: The question I have just asked is largely the substance or purpose of going into all that? A. Yes.

The Court: I thought I would go directly about it and not beat around the bush at all.

Mr. Lyon: All right. Now, as a matter of fact, compare the amount that run 2-E, which you reported in Exhibit PX-184, with this particular run that you have just been asked about, and tell me how much more this run is out of line than run 2-E is out of line? A. What is 2-E? Let us get the book.

Q. 2-E is out of line in Dow's favor, and I think you mentioned it yesterday as out of line. A. I think in my testimony I have indicated that in running a large scale set-up like this that there is certain leeway, and I have indicated this 10 per cent and so variation. I don't believe that you can run a large scale practical test, or make it prac-

tical and get the fine exactness that you can get in a scientific laboratory with a gram of material, and I have indicated that, and if this would have changed completely the picture I would have studied that to the nth degree. The picture we have presented, this does not change the picture one particle.

Q. I am not asking you that, and I object to the witness arguing on cross examination, Your Honor. I have asked him to compare run 2-E which he did report in PX-184 in which he has admitted already out of line in Dow's favor, the amount that that is out of line with the amount he says his tests we have just been inquiring about was out of line in Halliburton's favor. A. 2-E. It is out of line in the fact that it showed a lower amount of corrosion. But I don't recall any of the things that you determine in throwing the test out. Those are the things, when you collect a whole bunch of data and figures and you pick one and use it, you find some holes in that data, and then you find the differences and discrepancies in these, sometimes you throw out the final answer and the whole thing.

Q. I am not asking you that. I am asking you to point out, the point of my question, is Exhibit 2-E any more or any less out of line in this report than this test we have referred to in Exhibit 190 which you threw out? A. All of the work, as I recall the data that we took, the evidence indicated that 2-E was a valid run and I reported it in No. 1.

Q. I am not asking you that. Is it out of line compared with the other? A. Out of line in what way?

Q. With the results of other tests you included with it, by as big a margin as the figures of this discarded test? A. If you take that view of it, no.

Q. How near is it? A. I would say that the Menaul tests in these synthetic acids—

Q. (Interposing): I am talking about 2-E. 2-E. A. That is right. If I am saying something is out of line I have got to compare it with something it is out of line with. About the average of synthetic acids in the Menaul tests

might be 250 grams of iron dissolved, somewhere in that range. Very close to it. The synthetic acids in the Menaul tests all showed about 250, and the blanks 1,000. This was 101.4 grams from our analyses. That is a difference of 150 grams, from 250.

Q. How much per cent is that out of line from 250? A. Well, now, I say it is 150 grams of iron different.

Q. Then out of 250 it is 150 off, is that correct? A. It is off, if you take the averages of different kinds of tubing and the tests made, the average of averages.

Q. You have given the figure 250 as the proper starting point now, and this result which you reported in 2-E in Exhibit 184 is 101. A. Yes.

Q. Therefore, it is about 150 out of line from 250? A. That is correct.

Q. And you reported it? A. I reported it.

Q. All right. Now, how much in figures was the Test I in Exhibit 190, which you have referred to and which you threw out, out of line? Give us the figures? A. If it was 400 to 500, why it probably was—

Q. (Interposing): I didn't say "if." What are the figures? A. I don't have them.

Q. You gave the judge a direct answer a few minutes ago. A. I did not.

Q. To his question? A. I gave him 400 to 500.

Q. It was an important question, I thought. Now, what are the figures? Let's see if you are justified in your answer as to why I, being more out of line than Exhibit E-2 which you included. I want to know what the figures are. A. The answer that I gave the judge was based and the discussion that I had with the judge was based upon the numbers that we accumulated in getting this final calculated result. That question was whether the conditions were more out of line and the test was more out of line than the one which we incorporated, any one we incorporated in favor of Dow, and I say that the analytical figures as we went along indicated that there was something wrong with this work.

Q. You refuse to answer my question? A. No, no; I have answered your question.

Q. Answer it. A. But I refuse to answer the question to imply that I answer wrong to the judge.

Q. Just answer my question, if you will. A. I did not give the judge and I did not give anyone a definite figure for the amount of iron dissolved in this particular run. I said that according to Mr. Lightfoot it was 400 to 500 grams of iron dissolved, and if you take this figure of 250, the difference would be from 150 to 250 grams.

Q. I am not asking you that. If you will answer my question and stop arguing, why, we will get—avoid any misunderstanding. I asked you to give me the figures for the Run I which was discarded, what the starting figure is for comparison that you think is in line with the actual figure that you got in Exhibit I. I want to know how much it is different. A. I do not have the figure.

The Court: Where are they? Aren't the figures here? A. I don't think that we have them calculated. When we found that these analyses were off, I don't think we went through, and we kept that—

Q. (interposing): Doesn't Exhibit I—doesn't the data in DX-190 on Exhibit I show that 670 grams of iron were dissolved? A. I don't recall that it does.

Q. Will you look at it? It is right there. A. Will you look at it? (to Mr. Lightfoot).

Mr. Lightfoot: You mean this?

A. (After conferring with Mr. Lightfoot): The figures that are given in the book there on the iron content of the solution were run by an analytical procedure that is known as the gravimetric method for iron; and we found out after we had run a number of tests, that that method could not be used in the presence of lead, and this run had lead in it. The samples were taken and run for iron by a method which we verified in the presence of lead, a volumetric method, the dichromate method, and the analytical figures—I am not sure that we have them on this particular run, we had thrown them out on the basis of the figures or

analysis during the run, and I don't know whether we have the figures on this new method of iron analysis, but if we do, we can make the calculations.

The Court: When you started to make that run, you knew that there was lead in it, did you not? A. We knew that there was lead in it.

The Court: Didn't you know that you had a method that you could choose where you had lead in it? A. The method—we had samples that contained different amounts of lead. We had raw acid that had very little lead in it, and the gravimetric method there worked very well with the small amount of lead, but in some of these samples where the lead went up high, the gravimetric method would not work.

The Court: Is that something that was learned in this very experiment, do I understand? A. No, not in that very experiment. I don't recall exactly when it was learned.

The Court: I don't get the point. A. Well, the point is—

The Court: That you started this because you had used a method that was not applicable? A. No, no. We had analyzed for copper in the samples of acid, and we had analyzed the original acid for inhibition in the laboratory tests and we found that gave a very low inhibition and the analysis of the effluent acids, which was very low in comparison, which was not found in the other runs, and we decided that there was something wrong with that test, so we discarded it. Now, we subsequently learned that the method that we had used for determining iron was not only taking down the iron, but taking down some of this lead, and we ran all the samples that we could get to determine the iron by this new method, and this run which we had discarded, I am not sure we ran over again for iron. Do we have those figures?

Mr. Lightfoot: Yes.

A. He said we have them, so we can calculate this exactly, and we will do that, if you want it.

Mr. Lyon: I certainly do. A. Will you make a note to that effect?

Mr. Lightfoot: Yes.

Mr. Lyon: The next run in this book is run J, dated April 26, 1940, reported in PX-190, commencing at page 110 through page 117. A. That is 2-B, run 2-B in the report.

Q. And the next run reported in PX-190 commences at page 118 and runs through page 125 and it is dated April 30, 1940, and is entitled "Run K," and that is referred to in Exhibit PX-184 as run 2-A? A. That is correct.

Q. Then the next entry in PX-190 is directed not to further runs, but to what are entitled "Changes in procedure for chemical analysis"? A. That is correct.

Q. And they cover from page 126 to page 130 and are then followed by the entries of various actual chemical analyses determinations up to page 157? A. That is correct.

Q. Now, various of these chemical analyses which you reported at this point in PX-190 bear notations such as the one on page 131, which is entitled "Iron analysis," and you have written there "Not used in report." Did you make the decision not to use these various results as indicated in Exhibit 190 in the report? A. I think that is my handwriting. I am quite sure it is.

Q. Then we have another one on page 133 entitled "Chemical analysis, run 2-B, methods and results discarded," that is correct, is it not? A. Yes. Run 2-B is the one that we ran the acid through the crock or tank and then out.

The Court: Now, this is showing that—have you referred to another one there too?

Mr. Lyon: There was run A, it says "Not used in report," page 131. The item on page 131 there refers to run A. The item on page 133 refers to run 2-B.

The Court: What is the date of the one you called A?

Mr. Lyon: Run A—the first run in the book, November 24, 1939. That was not used.

The Court: Now I have got just three that were not used.

Mr. Lyon: You have got A, B, 2-B, and I were not used. A. Four runs.

Mr. Lyon: A, B, 2-B, and I. If you want the dates of those, run A was November 24, 1939, run B was December 16, 1939, run 2-B was January 13, 1940, and run I, April 18, 1940.

The Court: I have got it right now.

Q. Now, then, the next we have, commencing at page 135 of PX-190, the chemical analyses for run C, which run was dated December 9, 1938, and is run 1M in Exhibit 185. We stop making runs in this book and make chemical analysis.

The Court: Let me call attention to the fact B is the one I have used more than once. I have 2B not reported. That is the only time I have used one letter more than once. And neither B was reported. B wasn't reported and 2B wasn't reported.

Mr. Lyon: That is correct.

The Court: Now, I haven't in my mind the relation. We start a series of letters—A, B, C, and D. They bear some relation to each other. I haven't in mind the relation between B and 2B.

Witness: B was run with acid going into the steel tank, immediately out. 2B was run in exactly the same way. The same letter was used to designate the same type of run.

The Court: The same in every way? A. Excepting the tubing was different. Isn't that right?

Mr. Lightfoot: Yes.

The Court: You not only ran them in the same way but got—

Witness (interposing): —the same general results.

Mr. Lyon: Now, Your Honor, at that point in Exhibit PX-190 the entries take up the change in analytical methods and record chemical analyses, the results, and later as we will see, they take up additional subsequent runs. Beginning at page 135 under the title "Chemical Analysis Run C" are the results of chemical analysis on run C; and the

first values are given as item No. 1, entitled "Iron analyses," run 12-28-39; and there is a notation here in pencil. Your Honor, all of these entries are all in ink—I haven't stated to Your Honor that all of the regular entries in PX-190 are in ink, but some of these notes are in pencil. In the margin is written, "Results not used in report." Is that because you had to recalculate these results by some other method? This is entitled "Iron analyses gravimetric method." A. We did not use the gravimetric method in the report. I told you that the gravimetric method was used on some samples, and then we repeated and re-ran those samples with the volumetric method, which is the accurate method, and so we did not use those, and, as I recall, I went through, and where we had used the gravimetric method—

The Court (interposing): Did you know before you ran them that one was an accurate method, and the other not? A. No, because iron and lead is a rare combination to get together in a solution, and the methods that I have described in the determination of iron—in most of the text-books, they do not mention that lead is an interfering element, and it did interfere to some extent.

The Court: But did I understand you found out as a result of these runs and the experiments and analyses that it was inaccurate, in the reports? A. Exactly. The reason it was found out was this: These men that were running the analyses, the final determination is that you weigh up iron oxide after precipitating it out of solution, and iron oxide is red like iron ore and should be fluffy and hard, and I noticed on some of these samples, I just happened to pick up the crucible and inspected it and noticed that the iron oxide had become fused into the porcelain of the crucible, and iron oxide will not do that at the ordinary temperature of ignition, but lead oxide will do it, and, therefore, I suspected that some of the lead was coming down with the iron and gave us a high result on the iron, so we took the volumetric method and made up standard solutions of iron and iron containing lead and determined that

we could accurately find out the content of iron in the solution by that volumetric method, and we repeated all the analyses.

The Court: What I wondered, is that some information now that you can apply to all other tests all the rest of your life, that the one is accurate and the other not accurate, or does it simply mean that for this particular test it is. A. (interposing): Oh, no.

The Court (continuing): — it is not accurate. A. We used this volumetric method for every iron figure that is reported with the exception of one or two figures that are run by the gravimetric method for the raw acid or acid that did not contain lead. There are a few of those gravimetric figures that we did not re-check because there was no lead in the solution, and we know that that is an accurate method when there is no lead in the solution.

The Court: Why use the gravimetric method at all, ever again, then? A. Why, we had started out with the gravimetric method, and we are not going to use the gravimetric method in this book from then on.

The Court: I know. But are you ever, as long as you live? A. Oh, yes.

The Court: I am wondering whether it is something that is not an accurate method or— A. (interposing): No.

The Court (continuing): — whether it is simply something in connection with this. A. In connection with this case, the fact that lead and iron were both present in solutions, and there was an appreciable amount of lead in solution was the thing that made that method inaccurate for the determinations. If lead had not been present, if it was just iron and copper—

The Court (interposing): But you knew lead was present. A. We knew lead was present.

The Court: Well, did you know that when lead was present that the gravimetric method was not accurate or did you first learn that in your lifetime there? A. I am just trying to figure out how the method of analysis was started in. You see, I had two men that did my chemical

analyses, Reihl and Halverson, and as I recall it we had samples of the raw acid that had practically no lead in, and I told them in a brief discussion to use the gravimetric method, without any great amount of thought about the lead, and I think that if I would have given it any serious consideration, looked it up thoroughly in the literature, I would not have told them to use that method, and when I saw these fused precipitates I knew that they did not have pure iron oxide, and the method was not working, and then we went back and I personally ran about 90 per cent of all those iron determinations by the volumetric method, and the others reported are by the volumetric method, which we have proven to be accurate.

Mr. Lyon: The next item I call your attention to is No. 3 at the top of page 136, entitled "Chemical analyses, Run C, continued, lead analysis," which was run on 1-10-40, and a legend reads, "Crock comp." What does that refer to? A. I would think that would mean composite, is that correct?

Q. That means this synthetic composite of the crock? A. Yes.

Q. And the value of that in milligrams of lead per c.c. is .0059. Then the next item is composition of tank and the value is .39, and then the composition of the end is .49. What do those values indicate? A. They indicate that in this—that was run C, wasn't it? The crock acid was commercial acid diluted to 15 per cent with tap water, and that very low figure for lead is the lead content of that acid, practically no lead in it. Then the composite of the tank samples are the samples that were taken from this Menaul tank during a run and were analyzed and showed .39 milligrams per c.c., as you read it there. The acid leaving the end of the pipe was analyzed and showed .49 milligrams per c.c.

Q. That is correct. Now, does that indicate that the acid in its progress down the pipe picked up some more lead? A. No, it doesn't indicate that at all. It indicates what I have explained to you before, that in this Menaul

tank that lead chloride, when this sheet corrodes in the acid the lead forms lead chloride, and that lead chloride becomes some dispersed in the acid at the bottom, the acid in that tank during a run, which is not stirred, during a run was just drained down, when you dip the bottle into that tank the most concentrated acid is down near the bottom and it is from the bottom that the end of that tube, the tubing system is sucking the acid from the top of this lead plate where the concentration is greatest, and therefore it is logical to expect that the effluent acid which is being taken always from on top of that lead sheet, being sucked very close to the lead sheet, would be greater than samples you would obtain by dipping into the tank. And the other thing is if we had felt that was of any major importance, we would have made much greater investigation than we have of that.

Q. Isn't your statement a mistake there was no agitation in this run C because if you refer back to page 49 under the conditions of test run C don't we see that "15% hydrochloric acid to be passed into the steel tank to remain in the tank for six hours with mild agitation"? A. There are two steps there—three. You take acid from a stoneware crock, run it into a Menaul tank, then you spend six hours and occasionally stir the acid. You get agitation then. When the run starts, you don't stir it. The only agitation you get is by the 1 gallon per minute of the acid being sucked into the tube; so during the test there is no agitation.

Q. But during the six hours there is. A. Yes, but the samples of the inlet and outlet are taken during the test.

Q. In stating the composite of the tank was .39 and the composite of the outlet was .49, does the latter refer to the analysis of the material as it comes out of the bottom of the tank? A. The .49.

Q. Now, then, the lead content of the acid as it went into the pipe at the top was .39 and as it came out it was .49, wasn't it? A. I explained to you that that wasn't the case.

Q. I don't understand the explanation. A. Here you have a steel tank with some hydrochloric acid in that has been agitated for this six hours occasionally. During that time the lead sheet has corroded and formed lead chloride and some copper chloride. The lead chloride doesn't all go into solution and be evenly dispersed in this acid. There is some lead chloride of a thin whitish film on the lead plate. The lead chloride on the lead sheet which, of course, is being continually formed, and the loose particles which is dispersed not dissolved then tend to accumulate in the bottom of the tank; the concentration at the bottom when you let it set is greater than at the top. When we took samples of the composite of the tank we dipped into the tank and took the sample. The tube which is delivering the acid out of that tank was just an inch or two above that lead plate, so it was sucking acid by that lead plate, and naturally would have a higher lead content than samples we dipped out of the top or dipped out of the middle of the acid. That is why the exit acid in this run is higher than the inlet. As I said before, the reason it didn't disturb us much was it was very easy to see this lead chloride that we have shown and other people have shown, that the amount of lead in the range of .39 or .49 is substantially the same as an inhibitor.

Q. Well, then, you don't have an actual figure here for the lead content of the acid as you put it into the top of the pipe? A. I didn't say that. I believe the stuff coming out the bottom is substantially the way it went in.

Q. I am not asking you that. You don't have an actual figure— A. (Witness interposing): Of the analysis of the lead content going in. We do not.

Q. Do you have a figure for the actual lead content of the acid introduced into the top of the pipe? A. For all practical purposes the .39 is a good figure and .49, or an average, any way you want to take it.

The Court: What I understand you to say is you think it is higher in lead. I don't think it makes any difference but you think it actually is higher in lead content

than the average of the whole thing. A. At the bottom, right at the lead plate.

The Court: I say that you put in— A. (Witness interposing): Yes, that is correct.

Q. (By Mr. Lyon): Is that true of the figures you have reported PX-184 and 185 as to the lead content of the acids introduced into the top of the pipe? Are they subject to that same correction? A. I don't know what the figures are. I would have to see them.

Q. You know the figures, don't you, in Exhibits 184 and 185? Maybe you better take a look at them. Figures for the synthetic acids and the figures for the tank acids where you have given the lead contents, and tell me whether they are subject to this same explanation that you have given here? A. (After examining documents and books): We will have to get it out of the book. It is not in the report. Do you want us to go through the book and get the figure?

Q. Don't you report in Exhibits 184 and 185 that these were the amounts of lead that you found in the tank acids or the composite acids? I am talking about the inlet? A. Oh, the inlet?

Q. Yes. A. The figures are given in the report.

Q. Well, now, are they subject to the same explanation and correction that you have referred to in connection with this figure of .39, or did you use these figures— A. (Interrupting): I don't think you would get the same difference in runs—you might—if this pipe were right down on the lead sheet, you would get quite a bit of iron in the effluent acid. If the pipe were to—

Q. You must have misunderstood my question, because you are not answering it at all? A. I did not understand it then.

Q. You reported in Exhibits 184 and 185 figures of the lead content of the acid that was introduced into the top of the pipe? A. That is correct.

Q. Did you use these figures that I have been referring to in Exhibit 190 without correction, or did you correct

them in any way to take care of the feature that you have been referring to?

Mr. Wiles: You did not mean to include the exhibit that had the synthetic acids in it, because this factor does not exist there at all. There is nothing about synthetics.

Q. Well, I don't know about that. Well, all right, let us limit it to the Menaul acids. A. The figures that we reported in the report are the analyses of the samples that we dipped out of the tank.

Q. You did not make any correction? A. We did not make any correction for the effluent concentration.

Q. Let us refer to the next item No. 4 on page 136 of this chemical analysis for run C. This is entitled "Inhibitions, small metal samples, sample, weight, loss, inhibition," and there is the series from C-1 to C-8, and the weight losses are given. The inhibition is expressed in grams, meters per hour—I think that is meters, "Grams m. per hour"? A. I think it is meters.

Q. And the per cent is given, and for C-1, there is no per cent. For C-2, it is given as 28.5; for C-3, it is 32.0; for run C-4, it is 33.6; for C-5, it is 33.3; for C-6, it is 29.3; for run C-7, it is 28.6, and for C-8, it is 34.2. Then there is a marginal note in pencil, "Not used in report." Now, will you explain that table, and explain what the tests were, what these percentages are, and why you did not use them in the report? A. When we started in with this work we knew that Dr. Bartell was employing a small specimen in an inhibition test and a small volume of acid, and we used that in measuring the inhibition of acids in some of these tests as reported here. And the inhibition of our commercial acids all ran about zero or very close to it, within a few per cent of zero, on the same small test. And the inhibition of these synthetic acids or Menaul acids that we ran all ran around 30, between 30 and 40, which is very similar to the results Dr. Bartell got on the field samples that they had obtained.

But when we ran it through the big tubing here we got 70 per cent inhibition. And the thing that we couldn't ex-

plain was the difference between the inhibition obtained in those small scale tests and in the large scale test. We then thought that the results were probably due because the cutting of the little piece of metal used to work it and deform it a great deal, and therefore you have got a peculiar surface, the volume and the time in contact, and so we went to the method that we used in our subsequent inhibition tests for laboratory purposes.

We simply took a piece of actual tubing and we gave it the same type of cleaning as the tubing got in the large scale tests, and we used the same mass or volume of acid and area in contact with the acid that we used in the large scale tests and used the same time of contact that we did in the large scale tests. The only thing we couldn't duplicate was the agitation. And then we got very similar results in the laboratory and in the large scale tests.

And so in the small scale tests the inhibition there says "Do not use" simply because I don't recall that we reported any inhibitions in the report except this large scale, the one with the one inch collar of iron, of oil well tubing, the second laboratory test which we developed which gave us correlation with our large scale tests.

Q. Are these small scale tests that you refer to all these tests made with these samples? A. Made with the small specimens.

Q. They were made under laboratory control conditions, were they not? A. Yes, they were controlled.

Q. Carefully made? A. Well, I would say they are fairly carefully made, yes.

Q. Well, now, they all showed very much lower percentages of inhibition than the tests that you reported in Exhibits 184 and 185? A. That is correct.

Q. And you continued to make those tests of that kind and obtained those kind of results throughout all your work, did you not? A. No, sir.

Q. When did you abandon them? A. I don't recall when. Can you tell, Bill?

Mr. Lightfoot: I think starting with run 1-N, as listed in that book.

A. Run N in the book.

Mr. Lyon: When was run M made, can you tell us? A. Yes, I can give you the date. M, 12-23-40, December 23, 1940.

Q. That was made a year after your run A? A. Yes.

Q. And you continued to make these laboratory tests for the per cent of inhibition of reduction of corrosion and obtained uniformly all these results down around 30 per cent? A. 30 to 40 per cent.

Q. And you excluded them all from your reports, reports to the court here, that is correct, isn't it? A. We excluded them all?

Q. Yes. A. Yes, because we had this correlation between the laboratory and large scale tests and we felt this large scale test was a very valid test, and therefore to get a test that would correlate in the laboratory we could study acids before we ran them in this large scale test, if we wanted to, and therefore we wanted a laboratory test that would give us a practical result that would resemble in some way what we got in the oil well tubing.

Q. I notice on page 145, PX-190, a table entitled "Inhibitors, inhibitions, runs A through G. These inhibitions were run on the samples on the modified method, using 50 c.c.'s of acid, suspending the sample by glass hook from the specially prepared cap." I don't know what that is. A. Cap, I guess.

Q. Cap time 16 hours, sample and location is the first legend, losses is the legend for the next column, area is the legend for the next column, inhibition is the legend for the next column, and per cent the last. I suppose that refers to the per cent reduction in corrosion? A. Well, I would think so. Let me see.

Q. The date says run 5-7-40. I am going to read you parts, giving just the identification of the samples, and their location and the percentage of reduction of corrosion. A. All right.

Q. Sample A, location Crock, per cent—(reading from table): A End Composite 6%; 2B Crock 0%; 2B Tank

Composite 9.6%; 2B End Composite 16.5%; C Crock 0%; C Tank Composite 28%; C End Composite 26.6%; D Crock 0%; D Tank Composite 34.2%; D End Composite 34.3%; E Crock 0%; E End Composite 13.8%; F Crock original—and there is a star here in the footnote saying "Not Run" "Use D as 42.0 the average of the crock original for runs A, 2B, C, D, E and G; sample of crock and metal percentage 21.9%. Then Sample 1 End Composite 26.0, Sample G crock percentage zero, sample G End composite 5.8," and that is the rest of the percentages. Now, these samples designated, do they refer to the letters of the original runs as they were originally lettered? A. In the book.

Mr. Lightfoot: That is right.

Q. And the sample by crock means the sample was taken out of the crock? Mr. Lightfoot: Yes.

Q. And the end product means it came out of the tube at the bottom? Mr. Lightfoot: Yes, sir.

Q. The tank compound means the sample was taken out of the Menaul tank? Mr. Lightfoot: That is right.

Q. None of those results were reported in Exhibits 184, 185? A. No, because we felt those small tests did not represent what happened in an oil well tube.

Q. I am not going to take the time to point out the corresponding determinations and the results that were made with each one of these different runs. They are all here in the book, aren't they? Because your explanation covers them all. A. You mean the explanation of the small scale test?

Q. Yes, sir, as to why they were left out and they were left out. A. They were left out because we didn't feel that small scale test gave us a practical measure of inhibition. We ran the large test which we felt was much more comparable to certain figures, and we got the figure repeatedly in a total of eight runs. The second method of running the test in the laboratory we used the 1" pipe and gave results that compared close to the large scale flow tests.

Q. All right. That brings us up to page 156, because

I won't stop with the other analyses on the runs that have been performed up to that date. That brings us to a matter of copper analysis for runs K and L. You had to make a change in your method for analyzing for copper, didn't you, in the progress of this work? A. Yes, the method that was originally used for some of the earlier work was the method that we discussed this morning, earlier today, in the front of the book there. It was the first method received from Dr. Bartell and we learned that very shortly after he had sent us that method that he changed over to that other method he obtained from Dr. Willard. When we were apprized of that, we changed over and the figures reported in the report are all based upon this second method for copper.

Q. What did you do? Go back and re-analyze? A. Analyze all the samples we had to determine the content of copper.

Q. (By Mr. Lyon, continuing): Then, as a matter of fact, you originally analyzed these various samples from these various runs for both iron and copper by methods that you afterwards discarded, and you had to re-analyze all those samples by new methods, for their iron content and their copper content, is that correct? A. Not all of them; some of them.

Q. And that work of re-analyzing was done about a year after the runs were made, and after the original analyses were made, isn't that correct? A. That is correct. The results that were obtained, however, did not change the picture or the conclusions one particle. The analyses were—it was an academic study more than anything else. The loss in weight of the tubing that we calculated, and the per cent in difference that we found in the last were just within a per cent or two.

Q. When you say the results did not change, or that these differences in figures did not change the results, you mean within your interpretation of what the important result is; you don't mean that they did not actually change the figures supporting them? A. Oh, yes, they changed the figures. For example, when we ran a sample of acid

from the Menaul tank, it may have had one and a half milligrams of iron in it, and a half a milligram of lead in it; and we ran that by the old iron method, and we probably found 1.6 or 1.7 milligrams of iron there, a high result. That is in the Menaul tank. Now, in the effluent acid, we used the same method, and the effluent acid probably was 2½—let us say—or, two of the true value, and it had lead in it, and we probably found 2.1; in other words, both figures were up by the same amount, and although there was an error in the method, we got 1.6 milligrams in the Menaul tank, and 2.6 in the effluent. That is the difference which we used to calculate. The iron remained the same. And, therefore, after the iron had been repeated, the same conclusions were obtained, that there was 60 to 80 per cent inhibition in running the Menaul tank, the Menaul tank without wire, and the synthetic acids—the picture was exactly the same.

Q. Well, now, wait a minute. You say that the difference would remain the same, but the values were changed, raised or lowered as the case may be. A. Yes.

Q. Well, then, as you were reporting the results as a percentage, the change being a percentage of the whole, that would change that per cent. A. We don't do that.

Q. What do you do? A. We use the figure for iron in the inlet acid and the figure for iron in the effluent acid and take the difference to figure out how much iron has been picked up.

Q. But you report per cent of reduction in corrosiveness here based on those differences? A. No, sir; absolutely not. Those figures are not used for that purpose.

Q. Now, tell us about the copper. What actual difference in values did it make in these differences in the measurement of copper? A. As I recall the copper, the first method was the colorimetric method as well as the second, and the only recollection I have that was wrong with it was that it produced a color and that that color was fugitive. In other words, it would go away in time, and they had to adopt a standard procedure of just measuring

the color at the end of a certain time and that was not very convenient, and, therefore, there was a chance to make some little error there by the observer. And in the second method that color stayed and was quite permanent. Isn't that the main difference?

Mr. Lightfoot: Yes. A. That is my recollection of the two methods.

Q. Well, was there more than two methods? A. No.

Q. That you employed for copper? A. No, there was just two methods.

Q. You haven't tried any other method since? A. No other method for copper.

Q. I notice on page 156 a table entitled "Copper Analysis, Runs K and L, Carbamate Method." A. That was the second method.

Mr. Lightfoot: Yes.

Q. That was the method you actually reported? A. That is the good method, better method, of the two.

Q. That is the one you used? A. That is the one on which the figures are based, on the carbamate method. All the figures in the report are based on the carbamate method, as well as Dr. Bartell used that method.

Q. I notice on the left hand side of this page a note, "Results Discarded." But on the bottom of the column it says "Above samples analyses enclosed with report but questionable due to color interference." Will you explain that in the light of your testimony? A. The analyst that ran these samples wrote along the side of them "Results Discarded. See page 154 for re-run." In other words he must have noticed something was wrong or he did something wrong. "Above samples analyses enclosed with report but questionable due to color interference." "Above samples," that must mean these top ones. I can't interpret that last sentence there. Were these figures used?

Mr. Lightfoot: I don't know. A. I would like to have the book and take time to check it and find just exactly—

Q. (Interposing): You do that. We are going to

have two hours at noon, and I hope you can do it in that time. A. All right.

Q. It takes a long time to check some of these things. Now, the next entry in this book commences on page 158 and is entitled "Run L," dated May 11, 1940. And the write-up for that run goes through with the entry of results through page 165. And the Conditions of Test on page 161 are stated as follows:

"Fifteen per cent HCl to be passed into the steel tank and to remain there for approximately six hours with mild agitation. Then to be run through piping system at approximately one gallon per minute. The temperature of acid to be 85° F. Tank and T are not to be connected by any outside connection." And that run L is referred to in Exhibit PX-185 as run 1-N, is it not? A. That is correct.

Q. The next entry in the book begins on page 168, entitled "Run M" made December 23, 1940. The write up for that run continues through page 175 and the conditions of the test are stated at page 171 as follows:

"413 N HCl acid treated with $FeCl_2$. 4 H_2O $PbCl_2$ and $CuCl_2$ to be passed from the stoneware crock at 1 gallon per minute at 85° F. through the tubing system." That run is referred to in PX-184 as run 2-D, is it not? A. That is correct.

Q. The next entry in the book commences at page 176 and is entitled run N, dated January 7, 1941, and the write up for this continues through page 183. The conditions of run N are stated on page 179 as follows:

"413 N HCl acid was passed directly from the stoneware crock at 1 gallon per minute at 85° F. through the tubing system."

This run is referred to in PX-184 as run 2-C, is it not? A. 2-C is correct. That was reported as 2-C.

The Court: That goes direct, is what I was getting at. A. It goes directly into the tubing.

The Court: It didn't go in the tank at all? A. That is right.

Mr. Owen: It ran from the crock and went directly from the crock.

The Court: That doesn't apply to the reason why some earlier ones were discarded, because they didn't stay in the tank? A. No, it wasn't in the tank at all.

Mr. Lyon: The next is a write up commencing on page 184 entitled "Determination of Iron," and this continues through page 188, and I am going to pass it for the time being, but it has to do with the new method for analyzing iron. A. That is right.

The Court: That one of May 11, 1940, L, I should mark it reported; is that right?

Mr. Lyon: Yes. May 11, 1940, Run L, is Run 1-N in Exhibit 185.

Q. Now then we come to page 189, to what is entitled "Chemical Analysis of Run M" and No. 3, Item 3 is entitled "Copper Analyses, Carbamate method." A. That is right.

Q. That is the method that you say you adopted and actually used in your report? A. That is right.

Q. Now, there is quite a table of these copper analyses, and I notice a note on the side, "Discarded See page 256." Have you any knowledge of that? A. I will have to look at it.

Q. You have turned over to page 256. That has a table entitled "Re-Check of copper analysis, Runs D, J and M."

The Court: Can you tell us the occasion of making those and discarding the earlier figures? A. There is no date down here, so you couldn't tell just when they were run. We would like to check these figures.

Mr. Lyon: We were just calling attention to the fact that they had discarded certain copper determinations, and then it referred to a later page in the book, and there was a re-run of them, and the witness is going to make a statement. A. I would like to check the figures in the first table and in the second table with the figures used in the report. I just don't know what happened. (Checks figures.) The re-check, apparently, is just the same as the original determinations.

Q. Let me have the chemical analysis in run N on

page 190, and then on page 191 we have a table, "Chemical Analysis of acids from tanks," on page 192 we have a title "Study of facts involved in determining the rate of attack of acid on oil well tubing," and at page 193 we have a title "Time of contact versus rate of attack," page 194, "Time of contact versus rate of attack," on page 195 "Effect of ratio of and to area of sample of steel," page 196 "Effect of various atmospheric conditions of test," page 197 "Length of oil well tubing versus rate of attack," page 198 a table, "Effect of re-use of tubing," continued on page 199; page 200, "A comparison of freshly compared synthetic inhibited and with acid after storage"; page 201 "Effect of time and conditions of storage on rate of attack." In all I am reading you now there is no mention of time in your report Exhibits 184 and 185. A. Well, that is the reason, as I told you before, we wanted to get a laboratory test that would give us comparable figures for that large scale test and so we studied some of these factors that were different in the large scale tests from the small scale in order to get such a test, and we found for example that if you took a one inch collar of tube you got a substantial result, but when you took a three inch collar it went up for the last six inches in length, which was about as large as we figured we could go.

The time of contact had an effect on the percentage of inhibition, and one of the major factors, however, was this cutting of a small piece of steel, cutting and getting so much of an edge, that metal that has been worked very strenuously is different, and the final results are that test that we described, all this work, and to put in all those details, we didn't feel it was worth while. We tried to verify these reports to bring out the major factors involved.

Mr. Owen: Well, I will state in that connection, Your Honor, that these reports were not prepared with the idea they were going to be offered in evidence.

The Court: I understand. They are documents we are prying into for the purpose I indicated.

Mr. Lyon: Before we commence with the next run

entered in DX-190, I want to stop and ask you about a comparison that I note between this run I, which you did not report, with run H, which you reported under the number 2-M, and run A, which you did not report. I note that this run I, which I am interested in, that the conditions as stated at page 105 show that that was a synthetic acid, an acid made up of adding the copper and lead, and that you added about 4 parts per million of copper and 225 parts per million of lead. A. Does it state that I added 4 parts per million of copper?

Q. That is the figure that we get out of here, if it is any— A. (Interrupting): Does it state that?

Q. It says 15 per cent HCl acid, containing 2 $PbCl_2$, and $CuCl_2$, so the composition of acid is similar to that in run H, and run H gave about 4 parts of copper and 225 of lead? A. Similar is not identical.

Q. Now, then, in that test you would have a synthetic Menaul tank acid, run down the pipe, isn't that correct? A. We would have a synthetic acid of whatever concentration we had there.

Q. And run down the pipe. There would be no tank with the lead plate in it? A. No.

Q. And the connection to the pipe? A. No.

Q. Whereas in run H, which became 2-M, you did have the tank and the battery to produce the tank acid, and you ran that acid down the tank with the connection, with the so-called tank connected pipe—isn't that so? A. I believe so.

Q. Now, as reported here in this run I, which had no connection between the pipe and the tank with a battery in it, you found that in the—that during the progress of the acid down the pipe, the acid removed 670 grams of iron; whereas, in the comparable test H, which you reported as 2-N, where there was a connection between the tank with the battery, or the lead plate as the battery, and the pipe, the loss of iron, or the removal of iron in the pipe was 265 grams? A. That number 670 you have on a slip of paper there—you did not get that out of the report?

Q. Well, I have it here in a calculation that we have made. A. Oh, but I am very certain it is wrong, that calculation.

Q. Will you tell me, according to the results as you have them reported here, and calculate it, if necessary, the amount of iron in grams that were removed from the pipe, in the passage of the acid down the pipe in run I, which you did not report? A. I told you that I would have to have the book for some little time to make that calculation, and you wouldn't give me the book over noon.

Q. I am going to ask you to make that calculation, because if that is the correct amount of iron that was removed in run I, or approximately the amount, as compared with the amount of 265 grams, which is reported in Exhibit PX-185 as 265, the result obtained in run I in that respect is entirely contrary to the conclusion that you drew and reported in Exhibit PX-185? A. This morning I went into quite a lengthy explanation of why we discarded run I. And the run did not duplicate this other run. And the acid as prepared ready to run into the tubing had a very low inhibition measured in laboratory test and the acid run in the other run had a higher inhibition, almost twice as great.

Q. Now, why did you say you discarded run I? A. Because the effluent acid from run I was extremely low in copper, and we have definite reasons for believing that some mistake was made in the copper addition in that particular run.

Q. We are not interested in the copper addition. We are interested in the comparison of the amount of iron that was removed in the passage of the acid down the pipe. A. Wait. You have got to compare that when you are talking about iron removal, because there is a tie in between copper and inhibition.

Q. How much copper did you determine to be in the acid as you prepared it in the crock? A. I explained to you that we ran the sample and, as I recall it, the parts per million came out to be 4.

Q. Yes. A. That is about as I recall what we were

aiming at. Then the sample of the effluent acid came out to be about 1.3 or 1, and then the inhibition tests of the original acid showed about 16 per cent inhibition on this small scale test, whereas the synthetic acid that contained three or four parts per million of copper all ran 30 or 40 per cent inhibition, so—that is, on the small scale tests, and therefore we knew that something was wrong.

Now, it seems when we got all the figures together, we had no more of this original sample of acid and we couldn't go back and run the copper, but there was three things completely wrong with the sample, and this figure that we got, and the figure that we will give you is 471 grams of iron dissolved in that run, which is the corrected figure, still shows 50 per cent inhibition, and that is what one would expect if you had about one and a half parts per million of copper there.

In other words, the iron loss agreed with the concentration we found in the effluent acid and with the per cent of inhibition that we found in our laboratory test on the original acid, indicating that there was something wrong with that acid.

The Court: Let me see if I understand your statement. I got this notion, that acid in H was made by the lead plate in the system that you thought was comparable to the transportation tank. Is that right? A. That is correct.

The Court: I thought that H, after you had treated it in the way you thought was comparable to the transportation tank, that you did analyze it and find out what it contained. A. Yes.

The Court: The thing you prepared was I, synthetically, as you thought, to put in those same ingredients that by analysis you had found in H. A. That is correct. We thought we had put them in.

The Court: Well, now, wouldn't the natural conclusion of that be, of two treated in that way, that you would be more positive about what was in I than you would in H? What I was thinking was that the only way I can be wrong

—not the ego I, but the letter I—could be wrong would be by an actual mistake in making the synthetic? A. Yes.

The Court: While in H there is the opportunity always present in an analysis of not getting everything into it just right. I think of the two, in other words, if I was making up a batch of water and salt and sugar, and I took so much water and so much sugar and so much salt and put them into the thing, I would be more sure about what was in there than I would if somebody handed me some water and salt and sugar which they had mixed up and I went into the laboratory and analyzed it. Maybe my logic is poor there. A. Well, it is difficult to tell the different degrees of reasonableness, except that there are three or four factors here which enter into indicating that a mistake in weighing of the copper, or some factor like that actually occurred.

Q. (By Mr. Lyon): The copper was actually weighed out that was put into that in I? A. Yes.

Q. And you did analyze the acid after you made it up? A. Yes.

Q. And determined actually by that analysis that there was the four parts per million of copper present, did you not? Did you get my question, Doctor? A. I did not. I was looking for something here.

Q. I say after weighing out the amount of acid in accordance with what you found you needed, I mean after weighing out the amount of copper in accordance with what you determined would be necessary to add to correspond to the acid produced in run H, you did actually add that copper to the acid, and then after the addition and the acid was made up, you analyzed the acid and found by the analysis that there were 4 parts per million of copper present in the acid, as shown by your records, isn't that true? A. I have to refer to these records that I have to see exactly what was done, and after I do that I will answer the question. The runs that we are comparing are H and I. H is 2-N. April 13, 1940. In 2-N the parts per million of copper is 2.88, and the amount of copper that actually was added to the acid in run I is about 2.4 parts per million of copper.

The Court: Now what was H? A. H is 2.88 parts per million found by analysis. Added 2.4 and it was about two-tenths of a part per million of copper in most of these acids. I don't recall the exact number for that batch of acid, but that brought it up fairly close to the 2.88. Now, that is what was recorded in the book as having been made. The figure that was found by analysis was 4 parts per million in that acid, which on the face of it definitely indicates some mistake was made in the analysis.

The Court: How about this for the mistake, that there was something in H on your analysis you hadn't found that does this extra trick, how about that for a reasonable conclusion? A. That in H that there was something else?

The Court: There was some ingredient that you haven't yet found and don't know anything about that does this trick of the difference? A. I don't believe that that is the case.

The Court: What is there to disprove that? Wouldn't that be—if you didn't make any mistake in either one that would be a logical conclusion, wouldn't it? A. If there is absolutely no mistake made.

The Court: Yes. Then your conclusion would be that there was something in that H that you hadn't analyzed for, hadn't found. I don't know, maybe something, X, Y, Z. A. I believe that would be fairly logical, yes.

The Court: I don't know whether that is a logical conclusion or not. A. But it is one of the things that you have got to consider. First, the fact that 4 parts per million were found, and there was only 2.6 parts per million which was in there, if the man had weighed out the chemicals correctly, indicating that he made some mistake in that analysis.

The Court: I don't believe I have got that line of reasoning, Doctor. Give it to me again. A. The amount of copper chloride that was weighed out corresponds to an amount that would increase the copper content by 2.4 parts per million.

The Court: In other words, if you made no mistake

now you had the same amount of copper in both of these? A. About 2.6 compared to 2.88, or something like that, very close, if there was no mistake.

The Court: As I understand, you were making them as near alike as you could? A. Yes. And in the analysis the one sample I that was analyzed showed 4 parts per million. That was taken at the inlet of the tank in the run. That is out of the crock. This is a crock run in I. That sample showed 4 parts per million of copper, which is evidently higher than it could possibly have been unless some sort of a mistake was made some place. Then the analysis of the effluent acid leaving the piping system showed about 1½ parts per million, the copper solution leaving the pipe—about 4 samples of that were analyzed, and they all showed about 1½ parts per million of copper.

The Court: How long after you put this copper into that before you analyzed it and got the 4 parts per million? A. I don't recall the time.

The Court: I mean the one you made synthetically and you had it in what at the time? A. In a stone crock.

The Court: And you put in your copper, and then you analyzed it. You put in what would take it up to 2.88, and then analyzed it and had 4. A. Yes, that was what the analysis showed.

The Court: Now, how long intervened? A. Not a great deal of time. It was probably the same day, the same day the materials were put into the tank. And that is the figure that we question and we cannot check because we ran the inhibition of that sample and it showed an inhibition that would correspond to about 1½ parts per million of copper.

The Court: One and one-half? A. Yes.

The Court: Not four. A. No.

The Court: Nor not the 2.88. A. No. Something went wrong I cannot explain.

The Court: You think you made two mistakes, then? A. Everything except the four, yes. Two mistakes. I think that is possible.

The Court: You think out of the four two of them must have been wrong? A. No.

The Court: Well, now, there were only three places for mistakes, as I understand. One putting in this 2.88, or what would bring it up, the other analyzing it and finding the 4, and the other is the amount of iron that it ate. Two of those must be wrong. A. Two of those three, but there is this inhibition of the original acid which checked the 1½ parts per million of copper. We ran the inhibition of that original acid in the laboratory test, and that agreed with—

The Court: That analysis— A. That is, the acid that we took out of the crock. It attacked the steel in the laboratory test and it did not show as great an amount of inhibition as it should have if it had the 2.88 parts per million of copper in it. You see, we ran not only the analysis of the inlet acid but ran the inhibition of the laboratory acid.

The Court: Now, did you run an analysis of the commercial acid you bought? A. Yes.

The Court: Then you got four. How are you going to help those two mistakes? One is either you were wrong in analyzing the commercial acid or you were wrong in the amount of copper you put into the commercial acid, or you were wrong in the analysis after the 2.88 had been added together in that analysis, or you were wrong in your weights when you figured out that it had had a loss of 640 grams in the pipe. Now, is there any other place where there might have been an error? A. Well, let's go through them again. First, the analysis of the raw acid. The second is the weighing out of the copper.

The Court: That you put in with it to bring it up to 2.88. (Witness continuing): The third is the analysis of the inlet solution for copper.

The Court: Which means the solution after you had put the two together, put the copper in. A. Yes, sir.

The Court: The fourth is the testing of the inlet solution for inhibition in the laboratory test to test how effectively it was inhibited in the laboratory tests, a check on

its composition. That is what I referred to, as being on the tubing. A. Oh, no, that was just a little sample.

The Court: That is a laboratory test. Then we have the increase in iron content in acid running through the tube. All right. Now, then, the fifth? A. That was the fifth. Then we have the loss in weight in the tubing, sixth.

The Court: Sixth? Then the fifth I did not get. I thought that was the loss in weight. A. That is figured from the increase in iron content from our solution; that is, we determine the iron accurately by finding out how much iron was dissolved by the acid.

The Court: In solution? A. In passing through.

The Court: That is, how much of it was lost, in weight? A. How much the loss in weight was.

The Court: Now, you have got six. How many of the six must be wrong? A. I think probably two.

The Court: Two of the six? A. Yes, sir.

The Court: Have you any choice as between where they are most likely to make a mistake? A. The most likely—it is difficult to say, but it seems as though the weighing out of the copper would be the one least likely probable, and yet I think that is the one that probably is the thing that is wrong.

The Court: It seems like the least likely one? A. It seems like the least likely one to make.

The Court: Now, you have got to make another one. What is that other one? A. The analysis of the inlet acid, and the weighing out of the copper.

The Court: That is the other step that is one of the two? A. Yes.

The Court: Why have you reached that conclusion? You have picked for your first choice the one that you would be least likely to make? A. Yes.

The Court: Why have you done that? A. Because all four factors, other than those two, point definitely in the same direction. First, the effluent acid shows 1½ parts per million of copper. The inhibition that we determined on the laboratory test on the inlet acid gave an inhibition

corresponding to 1½ parts per million of copper. The loss in weight of iron of the tubing, the loss in weight of the iron in the acid both pointed towards that performance in the acid, which is about 1½ parts per million of copper.

The Court: Has there been any effort made to repeat? You couldn't get the same thing, but repeat in a similar way this experiment, and see how it would come out? A. Yes; we have two repeats on it, F and J. Run J is the repeat of this particular run and is reported in the report as 2-B. Run 1-B and run 2-B both are duplicates of this type of test.

The Court: Well, 1-B is F, isn't it? A. 1-B is F.

The Court: And what is the other one? A. The other one is 2-B. Run J.

The Court: 2-B. 2-B was not reported. A. Oh, yes. 2-B was reported.

Mr. Lyon: You mean 2-B in the new series? A. 2-B in the new series.

The Court: Now, then, you have run how many checks— A. (interposing): There are two checks on it.

The Court: You have run two checks one way and one check the other, then. A. We run two checks that we reported here.

The Court: You have run three checks or two in this method? A. Three in this method, yes. 1-B, 2-B, and the one not reported, but—

The Court (interposing): You have just got a fair majority. A. No, we have eight to one, nine to one.

The Court: But that is other reports. That is other methods? A. No, by running directly from the crock we have shown that iron makes practically no difference in the tests.

The Court: As I understand you, 2-B and 1-B are identical with those? A. Crock acid.

The Court: With the one that was not reported. A. With the Menaul.

The Court: In other words, I have been figuring them here, F and J were identical with I, and I am not taking

your new series. I am taking the old. A. F and J are identical with I.

The Court: F and J are identical with I. A. They have the same amount of lead, about 3 parts per million of copper, and they have 1300 or more parts of iron, quite a high iron content such as we got out of our Menaul tank, but we have two other runs that are in here, in which we prepared synthetic acids duplicating the analyses that Dr. Bartell turned over to us from the defendant's field tank samples, that have about the same copper and about the same lead, but the iron is somewhat lower, so there are four running from the crock with synthetic acid. Now, even if we take this run I and throw it in, it doesn't make a great deal of difference as we see it, and I would be just as willing to do that, if we say—

The Court (interposing): There is so much difference that I was — A. (interposing): No, the difference—

The Court (interposing): Don't you think that if we ran—I am not asking that it be done—a hundred times, you get 95 of them that would run along pretty close together, probably? A. I do not think you can check extremely closely. We have quite a bit of evidence on this I that something went wrong, and the weight loss is not the figure that Mr. Lyon gave to you. He gave you a figure he figured out erroneously, and not the figure we have given. The figure we have is 471 grams of iron lost, which is over 50 per cent inhibition in this run I, over 50 per cent inhibition in run I.

The Court: Which one of you are right? One of you is wrong. A. That is what I am supposed to provide proof to Mr. Lyon on when I can get that data book.

The Court: One of you simply make a mistake. A. So I wouldn't object to throwing that in as another run.

The Court: I am nof looking for an average. I am looking for the right. A. Yes. I did not feel that that was a run that would cause me to question seriously that something radically was wrong with our tests; that something happened on that particular run. Just what it was I can't explain.

The Court: As I now understand it, you have three others that you think are comparable with this method? A. We have four others.

The Court: F and J and what are the others? A. We have 2-D.

Mr. Owen: What is the original number? A. Run N and run Q.

The Court: O, P, Q. All right. Q you think is comparable with this? A. Yes.

The Court: And what other ones? Now, I have got as comparable F, J, Q and M. A. And I also feel that the runs using the Menaul tank where no wire was connected are also comparable, where there was no electrical contact that could possibly be exerted, and the composition of the acids run through there are comparable. The stoneware crock did not exert an effect and the tank when it was electrically disconnected could not exert any effect. So I would say there are at least six tests that are comparable with this run I, and run I, there are two-thirds of the facts which indicate something wrong, and even if you throw the thing in and say, well, assume that you weighed it out right—

The Court (interposing): That part doesn't interest me. I was interested in seeing whether it was in error, and I agree with you that I can't make it now, with the light I have, I can't explain it on any theory except that there has been a mistake somewhere? A. That was our belief, and that is why we did not include it.

Mr. Lyon: Even under your figures where the amount of iron eaten off the pipe in run I, to-wit,—what is the figure as you gave it? A. 471 grams.

Q. As compared with 265 grams in run H, run I is contrary to the conclusions that you reported in your reports, PX-184 and 185? A. It is somewhat off, I will admit that frankly.

Q. And the results of run I in that comparison would be favorable to the defendant in this case? If it was an error, it was an error in the defendant's favor, and not in the plaintiff's favor, that is true, isn't it? A. If we

had not found these four or five facts that indicated that an error had been made, then I would have seriously questioned all of the work that we had done.

Q. But that isn't the question I asked you, Doctor? A. Will you repeat the question?

Q. I asked you if there was an error, it was an error in the defendant's favor, and not the plaintiff's? A. That would be correct.

Q. Which has been true of each and everything that you have excluded on your own explanations today. Every time you made an exclusion that we have discussed, the error, or the point which you objected to, was always in the defendant's favor, isn't that true? A. I don't believe that is true.

Q. Mention one of the things that you excluded because it was in the plaintiff's favor. A. I can't recall all the things we discussed, but the reason for doing these things was to present a simple and concise picture of this in a practical manner, of these inhibiting effects of these metals, and not cluttering up of any report or dragging in millions of numbers to becloud the picture, is the thing that I did not want to do there. I have freely testified when asked for information about any of these tests, as to what our motives and what results we got, and so forth, and I have not hidden any errors that we made.

Q. You haven't answered the question yet. You have argued about it. A. I don't believe that all of the things we have dropped were favorable to the defendant.

Q. Can you name one that was favorable to the plaintiff? A. I don't recall.

Q. Well, now, let us go on. Commencing at page 218 we have the next run, which was run O, dated May 1, 1921. This covers pages 218 to 221 of Exhibit DX-190. It says, as to equipment, the same as had been used in run K. The tubing had been previously used in runs D, H, I, J, K, M and N. That means the same tubing that you—that you used the same tubing in all those runs, is that correct? A. Yes, that is correct.

Q. The conditions of the test are stated as follows: (Reading): "The tubing system was filled with crude oil. The oil was then drained, and the system sealed. Approximately 24 hours later the seals were broken, and the oil that had collected in the bottom section was removed. The run was started. The 15 per cent hydrochloric acid was passed directly through the tubing system from the stoneware crock at one gallon per minute at 85 degrees F."

I think that I brought out on cross examination that you had made this run, but you did not mention it in Exhibits PX-184 and 185? A. I believe it was brought out on direct examination.

Q. But it was not mentioned in your reports that are offered here in evidence? A. No, because the reports did not touch on oil.

Q. Well, now, I think you stated, or gave a figure based on this test as to the extent to which the oil tended to reduce the rate of corrosion. Now, what was that figure, Dr. Prutton? A. As I recall it, it was around 60 per cent, or 70, somewhere in there.

Q. How many? A. 60 per cent.

Q. Then it is probable, is it not, that if the acid were being fed through the pipe at a very different rate of speed, say six or seven or ten times as fast as you were feeding the acid through there, that the oil would have affected the amount of corrosion in some other figure, is that right? A. Well, the rate of speed would have something to do with the attack, and the amount of wiping off of the oil from the surface; but the inclination of the pipe would have a considerable bearing on just how it would wipe it off.

Q. Did you make any tests with the pipe upright? A. No, we did not.

Q. To determine what the effect of oil on the pipe would be? A. We made tests, in our laboratory tests, which was the—the tubing was practically in a vertical condition. It was the same pipe sections in the laboratory tests.

Q. Did you flow the acid through a vertical pipe that

had been oiled? A. No, I say we did not do that. We could not do it.

Q. Did you make any other tests except at this rate of one gallon per minute, I mean, where you had it at say, the rate of 750 gallons an hour, to see what the effect of the oil would be? A. No, we did not.

Q. Now, the next run in this book begins at page 222, and is run P, dated May 11, 1941, and the equipment is stated as follows, the same as had been used in run K; the tubing had been previously used in runs D, H, I, J, K, M and N and O. That is correct, is it not? A. I believe so, if you are reading from the book.

Q. The conditions of the test are stated on page 223. (Reading): "Before removing, each section of tubing was filled with crude oil and allowed to drain for at least twenty minutes, and then the section was assembled and the run started. Half of the acid was passed through the system very rapidly, and the remaining was passed at one gallon per minute, at 85 degrees F."

Did you get any values to show what difference it made in the rate of corrosion when the acid was being passed through the tubing quickly, as compared with a flow at one gallon per minute? A. Well, at this rapid rate. I don't recall the rapid rate. Do you recall that, Mr. Lightfoot?

Mr. Lightfoot: No, I do not.

(Witness continuing): It is in the book?

Mr. Lyon: I can't find it.

(Witness continuing): It was a very preliminary run and I don't know the rate that was used.

Q. I notice at the end of this under Mr. Lightfoot's signature, with his initials (I don't know whether he wrote it or not) page 225, the following note: "Comparison to other test invalid because of ratio of acid flow used in this test." Did you write that, Mr. Lightfoot?

Mr. Lightfoot: Yes, I did.

Q. Well, I take it from that, that comparisons of these tests are not valid, the results of these tests are not valid, where you have a marked difference in the rate of

acid flow, is that correct? A. They are sort of mixed up. The test, some of the acids run through fast, so slow, and it was sort of seeing whether we could get any figures out of this equipment at all.

Q. I take it from that note you arrived at the conclusion if there was a change in the rate of flow of the acid, that you could not then validly compare the results of the tests, is that correct? A. I think that comment was largely dictated by the fact that we feel that these tests we couldn't compare a test running acid through at 5 gallons per minute through the same tube as we could with one going one gallon per minute. That test was run with this mixed up rate of flow and therefore we didn't feel you could compare these figures with any of our one-gallon per minute runs.

The Court: Would the corrosion be greater when it ran rapidly? A. I don't know that that would be true. It should be greater. The amount of iron should be greater.

The Court: I say that that is the reason. What other reason? A. That is all, and the peculiar flow conditions of this oil that is in there.

The Court: Wasn't it all comparable except the speed? A. The speed and the inclination of the pipe which permits the oil to run up on the top surface of the pipe, whereas in a vertical pipe you have a different—

The Court (interrupting): All three of these were in the same position, weren't they? A. They were in this horizontal, practically, pipe.

The Court: As I understood it, I understood the three tests were all just exactly alike except the one you discarded had a different speed in it than the other. A. No, these are not the same kind of tests we ran before. These are the ones we ran the oil in.

The Court: How many oil? A. Only two oils.

The Court: How many did you save? A. Didn't save any. We reported the general results here in direct testimony but we didn't prepare a table of them because we didn't feel in almost a horizontal tube you get the same—

The Court (interrupting): But you treated all of those exactly alike. A. Exactly alike. It showed a reduction in iron.

The Court: As I understand there are figures that show the results, why you didn't report it, but do I understand in this book he is looking at there are figures about all of them? A. About the two runs.

The Court: And then there is one that you haven't got the figures for? A. No.

The Court: How many runs are shown there? A. Just two oil runs and all the data is there. I gave on direct testimony the general results of that test.

The Court: But I am talking about the figures in that book. There are figures there for both of them? A. Complete.

The Court: You haven't treated one any differently than the other? A. I just made a general statement. We didn't figure out the results of the test.

Mr. Lyon: There is a note at the bottom of the second run P "Comparison to other tests invalid because of the ratio of acid flow used in this test."

The Court: Now, does that apply to both of them? A. No, only to one.

The Court: Now, the only difference there and the reason you think that cannot be used is because of this difference in the flow, that part of the time it went faster than the other? A. No, that is not the entire story.

The Court: What is there in there that that should be discarded any more than the other? A. I don't think any of them should be discarded.

The Court: But you made the note. A. Making the note implies a comparison of a run in which we use 5′ per second flow. Every other one was run at 5′ per second.

The Court (interposing): Now, the conclusion I get as to why that one is less valuable than the other, do you think that one is less valuable than the other? A. I think neither one of them have any great significance, and that is what I testified.

The Court: Well, if there is any difference in value as between one and the other that I can see, it is because one ran at two different speeds and the idea is that a different speed makes a difference in the amount of corrosion. A. Yes.

The Court: That is the only explanation I get. A. Yes.

The Court: And this difference is that the faster it runs the more it eats. A. That is right.

Mr. Lyon: Now, just on that point, when you say the faster it runs the more it corrodes or eats the iron, you don't mean to say that if you are measuring the amount of iron in a gallon of the acid after it had gone through the pipe you would find a higher percentage? A. No. We discussed that.

The Court: I am talking about a measure of time. I am saying in an hour, as I understand, if the acid runs by at a rapid rate it eats more in an hour. A. Yes.

The Court: Than it does if it runs by at a slow rate, but I did not get the idea that if it ran by rapidly the gallon, one gallon, would eat more. In fact, if I was going to guess about it I would guess it would eat less. A. That is exactly what it shows.

The Court: Because it would have less time, that particular gallon, would have less time for its lunch.

Mr. Lyon: Did you make comparable tests of that kind and record them in this book, PX-190? A. There are some figures of iron content of the acid leaving the system, and I think it shows that, in this first part of the run, where it ran through fast, there was, oh, .2 milligrams of iron per cubic centimeter, and when it slowed up to one foot per second, why, there was .4, showing that the concentration of iron in the acid was lower, but I am quite sure that the total amount of iron dissolved was greater. We did not calculate that or measure it. We couldn't tell.

Q. That is what I want to know. You say you are sure about that. I haven't found any test of that kind in this book, if there is one. A. Here is the reasoning—

Q. (interposing): I am not asking about the reasoning. Have you actually got any tests in this book showing the total amount of corrosion in a given length of pipe if you pass different amounts of acid through it in the same length of time? A. No, I don't think we have the data. Mr. Lightfoot, do you know the rate we ran that through? Was that five gallons a minute or something like that?

Mr. Lightfoot: No, the first part of this run—

Q. (interposing): You don't know how fast that was, exactly?

Mr. Lightfoot: As fast as we could handle it conveniently. A. You don't know how fast that was? It was more than two gallons?

Mr. Lightfoot: Yes.

A. More than two gallons a minute. Just from his visual observation, it was more than two gallons a minute for the acid going through the pipe. The acid through at one foot a second picked up .4 milligrams per gallon and going through at that fast rate, faster than two gallons a minute, it picked up .2. It would be quite a good rate.

Q. Do you find those figures here? A. I say it isn't in the book and I can't prove it. As I explained before, those runs were simply runs made to see what would happen and see what kind of flow conditions would be obtained.

The Court: Can you tell me, Doctor, we have got two things to conjure with, that is the amount of acid passing over the iron, and we have got the length of time? Now, I understand that everybody is agreed, if not, I wish everybody would stop me in my thought, I understand that you are agreed that the longer the time to which a surface of iron is exposed, the greater the amount of corrosion? A. Yes.

The Court: And it is practically directly proportionate? A. Apprpximately.

The Court: Ignoring the speed is uniform now? A. Yes.

The Court: That is, it is pretty near in proportion to

the length of time, directly in proportion. Now, I do understand that you are also pretty well agreed that iron exposed for the same length of time at a speed of one gallon per hour, the corrosion is less than it would be if it was exposed twenty gallons per hour? A. That would be my contention, but—

The Court: I understand you. A. That is my belief.

The Court: I understand you and Mr. Bartell to say that? A. Yes.

The Court: Is there any question about it, or is that something discovered since, or is it well known? A. I think that is well known by practically every one in the acid treating business.

The Court: Now, we get down to a point, and I take it nobody yet has told me, and it is not so easy to see how the relation of the amount of corrosion compares to the speed. I am satisfied that it is not in direct proportion to that. I feel no hesitancy in saying I have got the notion that because it would eat a certain amount in an hour going at the rate of one gallon an hour, and you put it up to two gallons, I am sure it wouldn't eat twice as much, but can you tell me anything about that? Is there any mathematical figure of relation or proportion? A. I can't tell you any definite relationship. I think some of the men that run these inhibitions possibly could tell you, give you some better information.

The Court: You don't know of any scientific figures to enlighten us about that? A. No, I don't.

The Court: All right. I can see that is a more debatable and a more difficult question than the other. All right.

Mr. Lyon: The next experiment is entered in the Exhibit DX-190, commencing at page 227 and is entitled "Pressure corrosion test." The data on this seems to continue over and is concluded on page 231, signed by Mr. Lightfoot. You have already told us that you found pressure didn't make much difference? A. No. It makes a little difference, but it reduces everything in the same amount somewhat.

Q. All right. Now, the next run or the next entry in DX-190 commences at page 232 and is entitled "Run Q, June 24, 1941." The statement as to the equipment is as follows: "Same as has been used in run M, tubing had been previously used in runs D, H, I, J, K, M and N, O, and P." There seems to be no remarks on the condition.

The Court: That pressure one is what? A. That is the oil one.

Mr. Lyon: That is the second oil one. There were two oil runs, O and P.

The Court: All right.

Mr. Lyon: Now, there don't seem to be any remarks here about the conditions in this treatment, but this treatment Q is the one which was reported as 2-E in Exhibit 184, 2-E, that is correct, is it not? A. Yes. On page 237 the conditions of this test are stated.

Q. I was in error in my previous statement when I said there were no conditions given for this test. The conditions are on page 237 of the exhibit, and they read: (Reading): "4.465 NHCl acid treated with $FeCl_2$, 4 H_2O and $PbCl_2$ and $CuCl_2$, to be passed from the stoneware crock at one gallon per minute and 85 degrees F. through the tubing system." A. That is correct.

Q. I notice something that may have some significance here, in reporting how the copper was added in some of these other tests, copper chloride is indicated, whereas here the formula Cu_2Cl_2, which is cuprous chloride— A. There is cuprous chloride and cupric chloride. As I recall in some runs we used cupric, and then towards the end we used cuprous.

Q. Does that make any difference? A. The effect is immaterial in that the amount of metallic copper that is in there—the only thing that could happen would be that this cuprous—the cupric chloride would react with the iron pipe and would be reduced.

The Court: And you put that in by weight? A. By weight, yes, and you then figure the copper content.

The Court: I see. A. The reason we changed over

from one chloride to the other, and it would have absolutely no effect whether it is cuprous or cupric, the reason we changed over was that the cupric chloride, as you purchase it it is labelled $2H_2O$—it is in the form of crystals, in bottles, and seems to be partially dehydrated, and we did not feel that we could count that as well as the cuprous chloride, which is anhydrous.

The Court: But you take, say, a pound of cuprous chloride, just the same as you take a pound of the other? A. Yes. We chose the cuprous chloride because that comes in an anhydrous form, and the cupric came in a dehydrated form, and the crystals of it seemed to be partially dry, which would indicate it was not quite the pure hydrate, so we thought it would be more advisable to use the cuprous. There is no possible change that it can make in the test.

Q. In the title data on page 237 there is the following notation:

(Reading): "To 192 gallons of 4.465 NHCl, 420 grams of $PbCl_2$, 3.97 grams of Cu_2Cl_2 were added."

The Court: And that is what? A. Cuprous chloride.

Q. The second has twice as much copper in each molecule as the first? A. I don't think it is twice as much—I mean, atomically it is, but by weight—in other words, there are two atoms of chlorine to one atom of copper, and one atom of copper to two atoms of chlorine in cupric.

Q. Well, what I mean is there are twice as many atoms of copper in the second as the first? A. Oh, yes.

Q. This run Q was reported as run 2-E. We may already have covered that, but I say that to make it clear. A. Yes.

Q. Following the write up of run Q, commencing at page 240, we find various data recorded commencing with a title "Laboratory Tests on the Inhibiting Properties of Crude Oil on Oil Well Tubing in 15 Per Cent Hydrochloric Acid." And with notations on that subject. And then on page 245 we find the title "Study of rate of attack of hydrochloric acid on oil well tubing, small scale model, laboratory set up," with the title, "Sketch of Apparatus Used."

This apparatus shows two containers, each containing acid, and in each container a sample of tubing, one container sample of tubing is numbered A and the other is numbered B. And the tubings contain connection—are connected by a connecting wire outside of the two containers and extending across from one sample to the other, outside the acid, and then also connecting the two acids and extending to the two containers is a capillary glass tube, and then also connecting to the connecting wire previously mentioned, and the connection being outside the acid, but extending into the acid, is a lead sheet.

Now, will you tell me what you were trying to prove by that apparatus and whether you got any results out of it that proved anything? I see nothing about them in your reports. A. No. I told my assistant, Mr. Lightfoot, to see if we could fix up a demonstration that might be brought into court to demonstrate the fallacy of this Menaul process, and the difficulties experimentally that we encountered in getting the capillary full of acid, and so forth, and it just didn't work out very well, and we didn't even get protection over here of the oil well tubing with the lead, so it looked—the results would all indicate that it didn't protect any place. The things were so—it just didn't work. It was—

Q. (interposing): These tests or these recorded values that follow this, through to the title "Run Q Inhibitors" on page 252 were all the results of experiments on that attempted set up? A. Run Q?

Q. Up to where there is a title "Run Q Inhibitors—Inhibition." A. Oh, yes.

Q. If those are what they are about, I don't care to stop on them. A. No, there are some other things in between here.

Q. How far does that data go? A. It goes from here to here. There is 1, 2, 3 sides of a sheet. Is this included; is that part of it?

Mr. Lightfoot: Yes.

A. No, that is another thing, steel strip.

Mr. Lightfoot: Yes.

A. About two and a half sides of a sheet here discuss those crude attempts at trying to fix up a demonstration model to show that this thing wouldn't work.

Q. That is the end of page 247? A. Yes.

Q. All right. Then on page 248 we have a title "Demonstration Inhibition Test using Steel Strip alone and each steel strip coupled to a lead strip being bolted together above the surface of the acid and spaced about one inch apart in the acid." You remember that? A. Yes, that test was run, but I don't know how important it was considered, but when the Menaul patent was obtained they went into the Patent Office and had a lot of discussion with the Examiner, and the Examiner claimed that it wouldn't work, and then they proved that the potential is in the right direction, that it would work, and he still claimed it would not work, as I recall, so they got Dr. Gardner some place to run tests connecting the lead strip to a piece of steel and he showed you got 90, over 90 per cent inhibition.

Well, on the basis of that, they were awarded a patent. I think that was the determining point, because very shortly thereafter they were given a patent. And we were just checking up to see. We couldn't get hardly any inhibition at all. We got 20 or 30 per cent. If we had left the lead sheet in there for a length of time, for it to dissolve, maybe we could have got 90 per cent, but we did not check Dr. Gardiner's work.

Q. All right. Now, then, the next page, on page 249, it is entitled "Special inhibition tests using steel strips submitted by the Dow Company." What is that about? A. That was in connection with the pressure test work. I think we ran them outside the pressure bond and then inside the pressure bond, is that correct?

Mr. Lightfoot: Yes, that is right.

A. And I think these are outside. Are these outside?

Mr. Lightfoot: Those are outside.

A. At atmospheric pressure, and we used the same strips like the Dow Company used in their inhibition test.

Mr. Lyon: And then the next thing, on page 250, is a title, "Check on acid run O,"—I can't read that next word. A. Preliminary. In other words, that was a preliminary run.

Q. What was that about? A. That was one of those oil runs, wasn't it? Run O.

Q. Run O was one of the oil runs, but what was this check about? A. I don't know.

Mr. Lightfoot: That is the case where they checked the carboys for inhibition.

Mr. Lyon: And what did you find? Did you convert this to any per cent? A. After the run or before?

Mr. Lightfoot: Before the run.

Q. What did you find? Can you explain these results as to any per cent of inhibition, or reduction in corrosion? Mr. Lightfoot: That would have to be calculated.

Q. Was it calculated? Mr. Lightfoot: Well, it was calculated at the time. However, it is not entered in the book.

Q. Do you know what the results were, or have you got them at hand? Mr. Lightfoot: I can get them.

Q. All right. Either calculate them or find them. The next page is page 251, entitled "Inhibition of acid samples from old runs E, G, K, D, N, using crock composite and over-all end composite samples. Time, 3 hours, and 30 degrees C." Are these some more of those same laboratory charts with samples of metal and getting percentages of corrosion reduction that you have explained before? Mr. Lightfoot: Those are the large samples.

Q. The large samples. A. These are the end of the inlet acid of runs E, G, J, K, and M. Those are the blanks.

Q. These are the blanks again? A. They are laboratory tests that were run upon the inlet acid in the runs listed here.

Q. Were the results here incorporated or employed in the reports, Exhibits 184 and 185?

The Court: When you refer to blanks do you refer here to chemically pure acid or commercial acid? A. Commercial acids.

The Court: I think Dr. Bartell referred to chemically pure acid, and he referred to blanks. Here we are referring to blanks as commercial acid.

Q. That is correct, is it not? A. These are the commercial blank acids used in these particular runs, or the commercial acid diluted.

The Court: Just so we keep it straight. A. And the figures are not specifically listed in those reports, are they?

Mr. Lightfoot: I believe they are not.

A. I think in the testimony I gave some of this.

Q. As I understand, Doctor, at any time you made synthetic acid you analyzed your commercial acid and then you added to that whatever you wanted to? A. That is correct.

The Court: You never in any of your testimony or experiments dealt with chemically pure acid at all? A. We have used in our laboratory inhibition tests that I reported on, to study the effect of adding metals, we have used chemically pure acid to add metals in the laboratory tests.

The Court: Does your testimony show that? A. Yes, it clearly shows that.

The Court: All right. I am satisfied.

Q. Now, continuing the following pages up to the end of page 258, contains some similar work on inhibitions with lead and iron mixtures, and so forth. A. I don't recall what is in there.

Q. I come now to page 259, dated July 22, 1941, the day after this case started. The title is "The potentials across a lead sheet HCl and oil well tubing." What were these experiments, Doctor? A. They were checks on the Gardner affidavit that was used in obtaining the Menaul method and were to measure the difference in potential that occurred between a strip of lead and a piece of iron when put into hydrochloric acid.

Q. They were not checks across the lead sheet, hydrochloric acid, and the oil well tubing? A. Well, the piece of iron was the oil well tubing.

Q. Where was the lead sheet? A. Right in the same beaker with a piece of oil well tubing. In other words, we cut a strip, as I recall, out of a piece of oil well tubing, put a piece of lead into the beaker, and measured the voltage as it went across that little cell.

The Court: They were connected at one part? A. They were in a beaker like this (indicating) the top connected with a wire, the acid around it. That is the type of test Dr. Gardner reported.

Mr. Lyon: What was the purpose of this test? A. The purpose was more or less to see if we could duplicate Gardner's work. Somebody requested I do it, I think.

Q. Who requested it? A. I think Mr. Rebbeck.

The Court: Who is Gardner? A. A professor down in Oklahoma some place who made some tests and sent in a report of those in an affidavit to the Patent Office showing that this Menaul process would work. He made two tests in the laboratory.

The Court: And you were making these tests but while you were making these tests didn't that simulate according to your theory, the pipe when connected to the tank with the copper wire? A. It did not.

The Court: You say it didn't? A. Oh, no. Here we have a path of current that is direct and almost parallel; the pieces were almost together. It closely ties in with the condition they have where they have a lead plate in the bottom of the tank and a steel side, where the path is more direct.

The Court: In other words, the copper wire simply connected the two? A. That is right.

Mr. Lyon: Well, now, so we will understand your last statement, wouldn't the measurements of voltage in these tests reported here be somewhat comparable to the voltages you state you didn't measure in the Menaul tank? A. Well, if you will read those voltages, the voltage jumped quite a bit. In other words, it was variable, never very great.

Q. I am not asking that— A. Well, I can't answer in one word. I can't tell you exactly whether it is the same

voltage you get. I think it is in that order between the side of the tank and the lead plate, but not in regard—

Q. Mr. Lyon (interrupting): I am talking about what electrical pressure there actually is in a battery of the kind that we have in the Menaul tank. A. These figures are around a few hundredths.

Q. I am not asking you that. These figures would be comparable to the voltage or pressure in the Menaul tank? A. In between the side of the tank and the lead plate.

Q. These figures are comparable, isn't it true? A. I didn't say they were completely comparable. I said there was some general relation between them but I can't just tell you the general potential. If I may take the book and read the values. They skip all over.

Q. Well, first you determined the voltages with 4% hydrochloric acid, didn't you? A. Yes.

Q. Then next you determined the voltages with 7% hydrochloric acid, then with 10% hydrochloric acid, then with 16% hydrochloric acid, and then with 25% hydrochloric acid? A. That is right.

Q. Now, let's examine the voltages as you found them for 16% hydrochloric acid. You will remember you testified yesterday the voltage would not be as much as a tenth of a volt or .1½ volts. You testified to that, did you not? A. As I recall, I testified that we actually measured the potential between the tank and the tubing and it was on the order of millivolts, thousandths of a volt. The statement I made between the potential of the lead plate and the side of the tank I gave no exact figures but said it was on the order of a tenth of a volt.

Q. I thought you denied it could be on the order of a tenth of a volt. A. If I made that statement, I would correct it.

Q. All right. The figures, the voltages as you actually found them, as recorded on page 260 or Exhibit 190 for 16% hydrochloric acid, will you read them to the court? A. The figure is .18 volt.

The Court: Now, what is that? A. The voltage between a sheet of lead and a piece of steel.

The Court: These are all 16%? A. Yes. 18/100ths was the original voltage. As soon as it was connected it was 18/100ths. At the end of one minute it was 14/100ths. At the end of six minutes it was 15/100ths. At the end of nine minutes it was .158 volts.

Then a second run was made at 16 per cent.

The Court: You did the same thing over again? A. We did the same thing over again, with new strips. As soon as he could measure it it was two tenths of a volt. At the end of ten seconds, it was 11/100ths of a volt. At the end of one minute and ten seconds, it was 13/100ths of a volt. At the end of two minutes and ten seconds, it was 14/100ths of a volt. At the end of six minutes and ten seconds, it was 17/100ths of a volt.

The Court: This all had to do with 16 per cent hydrochloric acid? A. 16 per cent acid, yes. Now, if we go to the 10 per cent hydrochloric acid, the values are about .07 volts average. The values are—the values here were about .14, and so it is probable with 15 per cent it would be .12, or .13. The voltage changes with the acid concentration. And so the statement that it was about one-tenth of a volt—

The Court (interposing): Then it acts inversely—

A. (interrupting): The higher the acid concentration, the higher the voltage.

The Court: .08 is the average for 10 per cent acid. A. And for 16 per cent acid it is about .14. And so if we would calculate for 15 it would be around .13 of a volt.

The Court: Provided you follow these others out and you find them in direct proportion to the percentage and you do find them running upward. You have only given me two. A. I will give you the rest of them. At 4 per cent—

The Court (interposing): Have you the averages? A. Just by glancing at them I can tell you about the averages.

The Court: Give it. A. Four per cent hydrochloric acid, the average was about .04 volts. And with 7 per cent acid it was about .06. With 10 per cent, I gave you that, about .08. At 20 per cent the average is about .20, so it shows some progression.

The Court: That is voltage you are talking about. A. That is the actual voltage between the lead and the iron.

Mr. Lyon: When they are immersed in the acid? A. When they are immersed in this particular form of cell.

Q. The direction of that potential, or the pressure, the electrical pressure will be tending to force the flow from the lead to the iron? A. From the lead to the iron.

The Court: Tell me this, now, does this prove or disprove Professor Gardner's affidavit? A. The results are somewhat different than Gardner's affidavit, but they are in the same general direction, in this part of the work.

The Court: It doesn't tend to dispute it then? A. It doesn't tend to dispute it to any great degree. It is a matter of degree and not of difference. In other words, the current, this lead was negative with respect to the iron, by a definite voltage, which should tend to electrolytically protect the iron, and his conclusion on the voltage, we agree that the voltage is in the right direction.

The Court: Then it is corroborative of his, we will say. A. In general.

The Court: All right. A. But the inhibition that we ran was completely non-corroborative.

The Court: Is the Oklahoma professor going to be here at all?

Mr. Lyon: Professor Gardner is not, Your Honor.

The Court: All right. Let me ask another question. You say it disputes, or, rather, corroborates what he says about inhibition? A. About the voltage. About voltage but not inhibition.

The Court: Well, now, maybe I either misspoke or—it corroborates, rather than anything else, the voltages? A. It agrees in general with the voltage that he reported.

The Court: But you say it is disputed as to the inhibition resulting from that? A. That is correct.

The Court: Now, did he give his—I haven't seen that,—there are so many things here, I haven't that affidavit, but does he attempt to state there some claimed experiments? A. Yes.

The Court: Or does he state it from scientific opinion? A. Experiments. And we tried to duplicate those as close as we could. He reports from 90 to 97 per cent inhibition.

The Court: Did he tell how he did it? A. Not exactly. He told in a general way how he did it. He told the concentrations of acid.

The Court: Did he do it the best way or the worst way? A. We just took a way of doing it.

The Court: There are different ways of performing experiments. A. We just really didn't go into it to any degree at all. Because we got that one request to check this, and then the attorneys did not keep after us, so we dropped that.

Mr. Lyon: I would like to offer in evidence at this time a certified copy of the file wrapper of the Menaul patent on the defendant's Menaul tank system, No. 2,149,-617, so that I can read at this time Dr. Gardner's affidavit.

The Court: That is DX-191?

(The document above described was thereupon marked DX-191.)

Mr. Wiles: If the court please, we object to that. It is bringing in hearsay matter without any opportunity for us to cross examine. It is a self-serving declaration, where cross examination is peculiarly essential.

The Court: Not because it is proof of the thing stated, but in connection with the,—I take it all this comes out of cross examination, I take it that the witness now on the stand disputes the validity of that patent.

Mr. Wiles: Oh, no. Look, that is just the trouble with letting them go on a fishing expedition of this kind. At a certain time in this case we thought they might want to put Dr. Gardner on and prove this, and therefore we asked the witness to please make some investigations to see if Gardner is right. He gets it written down in a notebook. So far as that is concerned it hasn't anything to do with this case at all, I mean whether Gardner's affidavit to the Patent Office could be proved correct with regard to the

inhibition in their tank, didn't make any difference, that I know of here. Then they go and get this leave to look at our notes, and they find something that as yet isn't relevant here at all. Then they cross examine the witness and find in parts he disagrees with Gardner. Then they, having dragged out an entirely immaterial matter, they try to put in the file, and Gardner practically as a witness here, where we have no chance to cross examine him. Now, they have lugged in this stuff that hasn't anything to do with anything that the witness went into. We didn't intend to examine him about it, except possibly in rebuttal, or if they put Gardner on, or some equivalent man on the stand.

The Court: On what theory is that admissible? On what theory do you claim that is admissible?

Mr. Lyon: I claim it is admissible for two points. One, because the witness himself referred to it.

The Court: He only did on cross examination when you brought it up.

Mr. Lyon: I didn't bring it up, as a matter of fact. I think Your Honor was asking the witness some questions and it came out. A. I mentioned these tests we made were only preliminary tests.

Mr. Lyon: And he in his reports here, Exhibits 184 and 185, has mentioned this patent and disagreed with the patent and made some statements.

The Court: Those reports, are those the reports they put in evidence?

Mr. Lyon: Yes. They are the ones he put on through Exhibits 184 and 185.

The Court: I am going to go in now, if he is going—if you have attempted by direct proof to tear this patent you are talking about to pieces, why shouldn't I find out what that patent is about?

Mr. Wiles: All right: There are two things. There are two entirely different points. One of them is the Menaul inhibition of the tank, of the truck tank. The witness has said he thinks that works and adds some inhibition. We never questioned that at all, and that is what this

affidavit is about. Now, we say, and the witness has said that the claim of Menaul that by hitching up this little piece of iron he can inhibit down in the oil well, that that is just a plain fraud, and that isn't what this affidavit is about. The tests that the witness is now cross examined about, and that they are bringing this Gardner affidavit in, are those that relate to the inhibition within the tank. Now, we make those inhibitions in the tank and that is carried out in part by this lead plate.

The Court: Well, if I am going into that patent at all, I generally need to have the file wrapper here to know something about the patent. I will rule that that is not proof, that isn't proper proof for a defendant to bring in here, because the file and findings of the Patent Office, or somebody's affidavit, they are entitled to cross examine and know about. On the other hand, to the extent that you attack a patent, to that extent I feel I need to understand it and the theory on which it was, and all about it.

Mr. Wiles: For that limited purpose.

The Court: That is the purpose. I am not admitting the proof to dispute the document.

Mr. Lyon: I understand that. I agree with that.

The Court: I am not treating him as if he was a witness here. He is alive?

Mr. Lyon: Dr. Gardner? I never saw the man. I think he is alive.

The Court: Well, all right, I will assume that he is unless he is proven to be dead.

Mr. Lyon: I would like to read the affidavit, not as proof of the facts, but so that Your Honor may have it in mind, if you have any questions of this witness.

The Court: DX-191 is the file wrapper, and I am admitting it for an understanding of the patent, of the theory on which it was allowed, and the proper interpretation of the thing.

Mr. Lyon: The affidavit is entitled:

"In the United States Patent Office.

"In re Application of Paul L. Menaul.

"State of Oklahoma, County of ....., ss.

"F. T. Gardner, being duly sworn, deposes and says that he is a citizen of the United States, and a resident of Tulsa, State of Oklahoma; that he is Associate Professor of Chemistry at the University of Tulsa; that he has specialized in industrial chemistry and has made an intensive study of the question or problem of corrosion particularly in connection with oil field equipment.

"That his education has consisted of the following, and that he has obtained the following degrees:

"University of Oklahoma, 1 year.

"University of Illinois, 3 years, B.S.

"Cornell University, 3 years, Ph.D.

"That he has studied a copy of the application of Paul L. Menaul, Serial No. 116,786, filed December 19, 1936, for Method and Apparatus for Handling Acidic Solutions, and is familiar with the contents thereof; that he first obtained knowledge of the invention upon which a patent is sought in the aforesaid application on or about the 1st day of May, 1937, this having been called to his attention by the Ozark Chemical Company, subsequently by the Shell Petroleum Company; that both companies inquired as to whether this method and apparatus was operative, this information being desired by the Shell Petroleum Company in order to determine whether or not it was safe for them to use this method in the acidizing of their oil wells; that he made this investigation and determined that the method and apparatus were operative, and so reported to the Shell Petroleum Company.

"That officials of the Halliburton Oil Well Cementing Company, having learned of his research and experiments in connection with this invention, have requested that he study the application for patent referred to above and make this affidavit with respect to the said invention.

"That the operativeness of the invention may be clearly demonstrated by apparatus constructed as follows. The apparatus consists of strips of lead and steel immersed in a beaker of hydrochloric acid of known concentration as in Figure 1, Menaul 116,768"

Mr. Owen: Would Your Honor like to see that Menaul patent, and see the figure he is talking about? He is talking about Figure 1 there.

Mr. Lyon: That is right, of the patent as it finally issued.

The Court: That looks like I thought it would.

Mr. Lyon (reading): "said strips being not on closed circuit but connected by screw connectors to the wire terminals of the 'EMF' circuit of a Leeds & Northrup potentiometer having a sensitivity of .0002 volts, by means of which magnitude of voltage and direction of current flow were determined. The steel employed was a plain carbon steel of ap. .3% c. content. The lead was commercial sheet used for lining reaction chambers subject to action of dilute sulphuric acid."

The Court: What was the iron?

Mr. Lyon: The steel employed was a plain carbon steel.

Mr. Lyon (reading): "That he has conducted experiments with this apparatus at a temperature of ca. 30 degrees C. (86 degrees F.), and has obtained the following data on the voltages generated by the apparatus. In all cases the lead electrode was electronegative to the steel electrode; that is, oxidation or loss of electrons occurred at the lead electrode, while reduction or gain of electrons occurred at the steel electrode."

Then there is a table,

"%HCl by weight, and voltage."

"In all cases the lead electrode was electronegative to the steel electrode."

The Court: What do you think he means there?

Mr. Lyon: That means that the current would flow from the lead to the steel through the acid.

"3.50 per cent HCl," and the voltage was ".0455."

The Court: The voltage was what?

Mr. Lyon: At 3½ per cent hydrochloric acid, the voltage was at .0455.

The Court: That is comparable with what the doctor said.

Mr. Lyon: We have some more values. At 6.67 HCl the voltage was .0510.

The Court: And that is comparable.

Mr. Lyon: At 9.95 per cent HCl, the voltage was .0630.

The Court: Comparable.

Mr. Lyon: At 15.99 per cent HCl, the voltage was .0865.

The Court: We are getting off there.

The Witness: I said about a tenth of a volt, my figure was 12 or 13/100ths and is—

Mr. Lyon: It is .0865 on this table.

The Court: That is for what percentage HCl?

Mr. Lyon: That is for 15.99.

The Court: The doctor's is 14. There is quite a difference there.

Mr. Lyon: Yes, he is quite a little higher than this man, instead of lower.

The Court: Very much higher. That is the first place that they have been way apart. I would call that—maybe I am wrong in my yardstick, but I would call that, the others I look at as being—

The Witness (interrupting): That voltage is so low that two or three hundredths of a volt, Your Honor—I would say that those are practically check determinations.

The Court: Well, but there is a lot of difference where you put your decimal point. A. Oh, absolutely.

The Court: And his is a decimal and then a zero and then an eight. That is less. A. One-tenth.

The Court: And yours is over. A. Over one-tenth.

The Court: .14? A. That is true.

The Court: All right. A. But all I am saying is that voltage is small. You see, most galvanic cells, like a dry cell is 1.55 volts, and this voltage is only about one-tenth of a volt. This is practically nothing. Whether you consider one voltage or the other, we found, I would say that we agree with Dr. Gardner's voltage figures. That difference

in voltage, that slight difference is a few hundredths of a volt and it might be caused by a slight difference in the steel or the lead.

The Court: Yours is about twice as much. A. Yes.

Mr. Lyon: .14 and .086. A. It is almost twice.

The Court: Yours is almost twice as much.

Mr. Lyon: About two-thirds as much. A. Yours is about two-thirds of what we found.

Mr. Lyon: That is right. A. But I say both of them are negligible, in a galvanic sense.

Mr. Lyon: Then the affidavit continues:

"That he has conducted experiments to determine whether the corrosion of steel in hydrochloric acid is greater or less when connected to a lead plate as follows. Weighed steel electrodes as in the voltage experiments above were coupled with lead and immersed in hydrochloric acid solutions. After measured periods of time the steel strips were removed, wetted areas were measured, strips were washed, dried at 105° C., and weighed. The losses in weight (milligrams) per square centimeter of electrode area were computed. Companion steel strips not coupled to lead were subjected to the action of the same solutions for the same periods of time, and weight losses per unit area likewise computed. The percentage reduction in corrosion occasioned by coupling with lead was determined as follows:

$$\% \text{ corrosion reduction} = \frac{\text{mg./squ.cm.(coupled)} - \text{mg./squ. cm. (uncoupled)}}{\text{Mg./squ. cm. (uncoupled)}} \times 100.$$

"Data obtained in typical cases follow:

Then follows five columns headed "% HCl by weight," "Time hrs," "Loss of weight of steel mg./squ. cm. coupled to lead," "Loss of weight of steel mg./squ. cm. not coupled to lead," and "% reduction in corrosion due to coupling with lead."

I am only going to read the first column and the last column because the middle data is not needed here. For

13.47 hydrochloric acid, per cent reduction in corrosion due to the coupling with lead was 93.5. For 14.7 per cent hydrochloric acid, the per cent of reduction in corrosion due to coupling with lead was 97.0. For 13.7 hydrochloric acid—

The Court (interposing): That is right back where the first was.

Mr. Lyon: The first, the time for the first was six hours, the first two, both of them were six hours. Over a period of six hours.

The Court: All right.

Mr. Lyon: Now, the next two are for a period of eighteen hours, three times as long.

The Court: All right.

Mr. Lyon: The next item, 13.7 is 92.4 per cent reduction in corrosion due to coupling with lead. And the next item, 14.7 per cent hydrochloric acid shows 93.5 per cent reduction in corrosion due to coupling with lead. Then the affidavit continues:

"That the textbook of Inorganic Chemistry by Partington, published in 1927 by McMillan of New York, which gives the electromotive series of metals as listed by the examiner in the Office Action of August 16, 1938, is correct only under certain specified conditions and under other conditions the electromotive series there listed is not correct. The table listed is the table of 'normal electrode potentials.' The normal electrode potential is the potential exerted between a metal and its ions when the activity of the ions is unity. (See: Outline of Theoretical Chemistry, Getman and Daniels, 6th Edition, John Wiley and Sons, 1937, pages 429 and 430.) If the activity of the metal ion is decreased the electrode potential at the boundary between the metal and the solution of the ions becomes more electronegative (Loc. cit. page 439). There are numerous ways of decreasing ionic activity. One process causing profound decreases in ionic activity is the formation of a complex ion or molecule involving the metallic ion. The commercial cyanide process for gold recovery from low grade ores utilizes the change in electrode potential brought about by formation of a com-

plex ion from gold and cyanide ions. The normal electrode potential of gold is ca. 1.5 volts electropositive to hydrogen. In a solution containing an excess of cyanide ion, however, gold is electronegative to hydrogen. (See Cyaniding Gold and Silver Ores, Julian and Smart, Lippincott, 1907, Pages 69-72, incl.)

"The normal electrode potentials of zinc and copper are 1.1059 volts apart. Upon addition of an excess of cyanide ion to a solution of zinc and cupric ions the resultant electrode potentials of the two metals against the solution are of the same numerical order due to complex formation, making possible simultaneous discharge of the two metals from solution in commercial electroplating of brass. (See Applied Electrochemistry, Allmand and Effingham, Longmans Green, Second Edition, 1924, page 358.)

"Authorities are in agreement that a complex of some type is formed when lead reacts with hydrochloric acid. (See Mellor, A Comprehensive Treatise of Inorganic and Theoretical Chemistry, Longmans Green, V. VII, 1927, p. 714; Treadwell, translated by Hall, Eight English Edition, corrected, John Wiley and Sons, p. 218), although the exact nature of the complex is not established.

"Iron does not form a complex ferrous ion in HCl solution. When Pb and steel electrodes are immersed in HCl solution, and coupled, the lead electrode, due to the complex discussed above, is electronegative to the steel electrode, as shown in the table of voltages above and as indicated by the corrosion results cited above.

"F. T. Gardner.

"Subscribed and sworn to before me this 27 day of August, 1938.

"C. L. Thompson,
Notary Public."

Mr. Lyon: Now, I don't see anything in Dr. Gardner's affidavit here that has any of the iniquities about it. As you see, this current extends down an oil well pipe; he hasn't said anything about that. He has just established

the voltage and the direction of the flow of current in the electromotive series, and I don't think the witness has seriously disagreed with him on that.

The Court: He disagrees as to these results obtained here, as I understand. A. You have gotten out of me some preliminary work that we did in which I told the court that I disagreed—that I agreed quite closely and in general in the voltages. And then we ran a few inhibitions, and we got practically zero inhibition instead of 90 per cent.

The Court: That is where he disagreed.

Mr. Lyon: I see. A. They are preliminary results. But they indicate that with certain types of metal you get a slight inhibition.

The Court: You might have to disprove it; it isn't very severe, because there are so many chemists and you have so many you can readily run any, if you want to show me that that is the results you have obtained.

Mr. Lyon: Very well.

The Court: I think you intend to do that.

Mr. Lyon: That is right. But I want to point out Dr. Gardner, in talking about inhibition, percentage of inhibition, I don't think he was talking about oil well pipe. A. No, I don't think so.

Mr. Lyon: I think he was talking about the tank. A. Yes.

Mr. Lyon: He disagrees with him about the tank. A. I say we don't. I say we ran a few preliminary tests and the tests showed some inhibition when we used a piece of steel and covered the strip of it in the beaker with the lead sheet, we got 30 or 40 per cent inhibition. And when we used a sheet of strap steel we got no inhibition.

Q. But your tests have not gone far enough so as to disagree as to these values reported by Dr. Gardner as they apply to the tank rather than to the tube? A. I would say that from 95%, that is a tremendously high figure. I just can't see how when I got zero on several tests, 30%, approximately on another test, all of a sudden it is going to jump up to 95%.

Mr. Lyon: We have witnesses, Your Honor.

The Court: There is something funny in there as to why one gets zero, the other 93.

Mr. Lyon: That is pretty nearly as far as you can go. Only seven more. A. These are simply preliminary tests. I seriously question—

The Court (interrupting): How can you get zero if there is quite a lot there? A. Those are the results we got on this test.

Mr. Wiles: These tank tests showed a considerable pick-up in the iron in the tank which showed there was a lot of inhibition left to be done. Every time they put acid in the Menaul tank they picked up a lot of iron in it, showing the tank was being eaten away.

The Court: What kind of a test did you make when you practically got no inhibition? A. We took a sheet of strap iron, cleaned it up, as I recall, by sand-blasting or emery cloth.

The Court: As I understand, you followed as near as you could the teachings of that affidavit? A. Very similar, even closer together than that affidavit showed.

Mr. Lyon: I haven't found the results of those tests you last referred to in Exhibit 190. Maybe they have been made since this book was written up. Are they in this book 190?

Mr. Lightfoot: I believe they are. A. See page 9 for data, it says here (witness reading from book).

Q. That is part of Dr. Bartell's report that you originally started with. A. Oh, yes. 245 and 249.

Q. That seems to be (looking at book) that very queer apparatus that you said wouldn't work. Is that what you are basing that on? A. We ran a piece of lead in here (indicating) connected directly across with this piece of tubing, and we determined the inhibition. We put one strip of lead in here (indicating) and this section of oil well tubing with an extended arm on it and connected across between the two and found that when we connected it we got a reduction in attack of this piece of tubing of about 30%. I have the figures right here. Then we ran a test using

strap iron and putting the strap iron about an eighth of an inch away from the lead strip and inserted it in a beaker with a screw connecting up outside of the solution, and we got practically zero.

Q. What conclusion can you draw from that? A. I can't tell you. It was a preliminary test. When you asked me about whether the lead would protect the tank, I said it probably would to a limited degree.

The Court: Well, how do you explain in one you got about 30% inhibition and the other practically zero? A. Two different kinds of metals.

The Court: Is that the explanation? A. Possibly. The shape of the metal is different in the oil well tubing where we got inhibition. In other words, it was round. We had a strip outside here (indicating). It differed somewhat from Gardner's test. We got inhibition there.

The Court: When you got 30% were you nearer to Gardner than the other? A. Gardner reports 90 plus per cent.

The Court: I don't mean that. In the performance of the test. A. The one we got zero we were closer to Gardner in the method of performing his test.

Mr. Owen: In the one you got zero did you follow Gardner? A. Very similar. Two strips of lead, and we put them closer together than Gardner shows.

Mr. Owen: And did you connect them? A. Connected them together.

The Court: Don't tell me the differences now but tell me to what you yourself now attribute the different results in your two experiments where in one you got 30% and the other something else. If there are differences, you know; don't tell me the difference. Just tell me to what you attribute that difference. I want to get your idea. A. I imagine there is difference between potentials between the lead and different kind of iron.

The Court: You think it resulted from the different kind of lead you used and different kind of iron? A. Yes, and a matter of the difference in potential.

The Court: Have you told on the record what that difference was? Does the record now show? A. I don't recall. You mean in these little tests?

The Court: You attribute your difference in one case you got practically zero, the other case you got practically 30% inhibition, and you attribute that difference to the difference in the kind of iron and the difference in the kind of lead used in the two experiments? A. I believe that was the reason.

The Court: Tell me, then, what kind of lead and what kind of iron you used in the experiment where you got no appreciable inhibition. A. That was a sample of strap iron.

The Court: And what kind of lead? A. And the lead was chemical lead, I believe.

The Court: Chemically pure lead? A. No, a chemical grade of lead, just the kind they use in the bottom of these Menaul tanks. It was not chemically pure. It was the chemical grade of lead which they use in the Menaul tanks in the field.

The Court: All right. Now, tell me what kind of iron and what kind of lead you used in the experiment where you got practically 30 per cent inhibition? A. That was this oil well tubing cut out of lengths of this 1¼ inch tubing, and the lead was the same exactly. I think it was the same strip, wasn't it?

Mr. Lightfoot. No. A. It was off the same piece.

Mr. Lightfoot: A lighter grade of lead. A. Was it the same kind of lead?

Mr. Lightfoot: Yes.

The Court: You don't attribute it to the difference in lead? A. No, not to the lead, to the iron.

The Court: You attribute it entirely to the iron? A. Yes.

The Court: In other words, one was easier biting for the HCl than the other? A. That probably was it.

The Court: Well, all right. A. I hate to make real definite statements on three laboratory tests.

The Court: Your best explanation you can give me as to why— A. (Interrupting): I don't like to go on record as making any hard and fast numbers.

The Court: I understand that.

Mr. Lyon: Now, also there was furnished to us in response to our request for additional reports, if any, correspondence, six binders which don't seem to add very much in so far as some of them are concerned, to Exhibits 184 and 185, because they seem to be preliminary copies of those, but there are some additional statements I would like to call Your Honor's attention to. This binder I have here, which is entitled "Progress report on Menaul test, submitted by C. F. Prutton, March 1, 1940," is a copy of a report that you submitted to the Dow Company on that subject on that date? A. Yes.

Q. And it covers largely the same material which is now incorporated in PX-185? A. That is correct.

Mr. Lyon: I call your attention to the last page, which is entitled "General comments." "No. 1. The rate of attack of hydrochloric acid on various lengths of tubing seems to vary considerably from length to length and be quite dependent upon the method of cleaning the metal surface." Was that a correct statement of what you had found up to the date of this preliminary report in your test? A. I believe it was.

Q. And is it still a correct statement of your observations? A. I think so, yes.

Q. "No. 2. In duplicating the Menaul procedure the amount of inhibition exhibited was much greater than would be indicated by the chemical inhibition shown by the entering acid."

Was that likewise a correct statement of what you had found at the date of this preliminary report? A. I don't recall. I don't think so.

Q. You don't think that statement is correct? A. I don't recall. This report was written—may I ask Mr. Lightfoot? This was written before we ran these analyses for the improved new method?

Mr. Lightfoot: They were.

A. This report, on this preliminary report we ran the iron determinations by this inaccurate method with lead in them, and the conclusions would be based on that, and if that is the conclusion, why it was corrected when we received the analyses on the acid samples, and those analyses were repeated at last Christmas time, very close to Christmas.

Q. After and subsequent to your submitting this report, preliminary report of October, 1940, to the Dow Company,—I believe you submitted it to Mr. Rebbeck, did you not? A. I think they went to Mr. Rebbeck.

Q. Did you receive any communication from Mr. Rebbeck or have any discussion with him about the contents of this preliminary report? A. I don't recall definitely the conversations. I believe I talked to him about every report we sent to him.

Q. Now, as a result of some conversation or some communication, you were asked to do something to produce a different result from the one that I have just indicated, were you not? A. No, sir; that was not the case. The case is that we kept on working on the problem and we discovered these errors and we corrected them.

Q. This last comment, No. 2, that I read to you, which you state is not correct, in your opinion? A. I don't recall. I would have to look through this report.

Q. That is just contrary—wait until I finish my question, please—is just contrary to what you have reported in Exhibit 185, is it not? A. It is contrary, the statement.

Q. And you corrected that as a result of going out and getting some different method or new method after the date of this preliminary report? A. A correct method of analysis.

Q. Well, isn't it quite true that Mr. Rebbeck indicated that something like that would have to be done, because he couldn't use the results as you reported them in your preliminary report in this case? A. Absolutely not. Mr. Rebbeck didn't indicate that at all, and we continued

doing work to accumulate more data, and this report is on the results of a few of those very preliminary tests. I don't know how many tests there are in this report. Can you tell, Bill? You are the one that got the report together?

Mr. Lightfoot: They are all different sections of tubing, I believe.

A. I think these runs could be—this could be very well explained. It will take some study to do it, and I don't think the conclusion is valid at all. I would like to take this overnight.

Q. Sure. Doctor, if you have anything you want to correct in anything you have said on cross-examination, why I am sure I want you to have an opportunity to do it, and if you let me know why I will ask the court to allow you to be given that opportunity. Now, I did ask yesterday—

The Court: All witnesses in my court can do that. I am looking for the facts, and that is all.

Q. Plaintiff's counsel didn't let me have the correspondence between this witness and Mr. Rebbeck. A. I have that. Do you want it?

Q. In view of the fact it is referred to at several points in Exhibits PX-184 and 185, I would like an opportunity to review that correspondence to see what the views are that were exchanged between this witness and Mr. Rebbeck in regard to the work that was to be done, and what the results were. Is this the complete correspondence? A. That is the complete file of correspondence to everyone connected with these tests, I mean, not only to Mr. Rebbeck.

Mr. Lyon: I will examine this this evening, Your Honor.

Mr. Lyon: Now, have we, as a result of PX-184 and 185, and these notebooks, and these additional preliminary or tentative reports that you furnished me, before us for study all of the experiments, and all of the work that you have done for this case, at least up to the start of the trial? A. Up to the start of the trial, or just shortly before. We have some laboratory inhibition tests that were reported in

the presence of oil that are not in these books, and they were completed after the start of the trial, and the books were not available to put the data in.

Mr. Lyon: I think that that is as far as I can go with my cross-examination, and I may not have any more; but I would like to look over this file of correspondence tonight, Your Honor.

The Court: All right.

Mr. Lyon: I am returning to counsel the six partial reports, or preliminary reports, and one of the two volumes he gave me is an empty book, except for two or three pages.

I am going to ask that the court receive as Exhibit DX-190 the original record book which I examined the witness on, and there is nothing in it except practically this data on this case.

Q. Dr. Prutton, I don't believe you testified to any determinations made as to the percentage of corrosion reduction or the percentage of inhibition of the Halliburton storage tank acids. Did you make any such tests of the acids that you made to simulate them? That is the acid in the storage tank before it is acted upon in the transportation tank. A. I don't recall that we did. If we did that it was some isolated test that we made, and we did so many of them.

Q. Do you know a Mr. Harold Robinson of the Dow Company? A. Yes.

Q. What is his position in the Dow Company? A. He is a physical chemist, in the Physics Laboratory there.

Q. I show you in your file of correspondence a letter addressed to you, dated September 12, 1939, signed by Mr. Harold Robinson. Did you receive that letter from Mr. Robinson? A. Yes, I received that letter.

Q. And the letter contains this statement, does it not, "We would prefer to use the same commercial acid (General Chemical Company, Chicago) as was used by Halliburton in the well treatments with which we are concerned, if we could be sure that the acid would have inhibition of the same order (10 to 15 per cent) as the Halliburton stor-

age acid. We have observed occasional high inhibition in this and other commercial acids. I should say that there might be an advantage to using Graselli acid in that you would probably have a chance to check on the inhibition before buying it in any large quantity." I have correctly quoted the letter, have I not? A. I don't recall.

Q. Just read it over, if you will. A. You quoted correctly from the letter.

Q. Now, you understand from this letter that the Halliburton acid corresponding to that used by Halliburton in the well treatments which had been sampled was acid from the General Chemical Company of Chicago, and was inhibited and contained in its raw state inhibition as high as 10 to 15 per cent, did you not? A. Well, the story of the initiation of this work is not simply—cannot be taken from one letter. There were a series of conferences and discussions that were held between myself and Mr. Chamberlain, and also Mr. Rebbeck.

Q. I asked you if you had that understanding of this paragraph. If you will just answer that question, then we will get along to another. A. I didn't pay any attention to that paragraph.

Q. You didn't? A. No. I did not pay attention to a lot of things that Robinson told me to do. He was a sort of an assistant in the laboratory with Mr. Chamberlain, and instead of specifically following his instructions I took more of my general directions from these conferences with Mr. Chamberlain, who was his superior. Robinson suggested, for example, a tremendous amount of electropotential work that would have taken months and years and many men to do, and I simply didn't follow that.

The Court: Is Robinson still with the Dow Company? A. Yes, he is.

Q. Who suggested that you make your comparisons and your experiments with Graselli acid, which, as you have suggested, was practically chemically pure, rather than with raw commercial acid of the type used by Halliburton, which in its raw state was 10 to 15 per cent in-

hibited? A. Well, I can't enlighten you upon that. You found in our books and we evidently ran inhibition tests on this Penn Salt acid and Graselli acid and found some slight inhibition, and the purpose of the tests, as I saw it, and I was given quite a good deal of latitude, not at all times specific instructions from these men at Dow. I received letters from Robinson with many detailed suggestions, but I followed very few of them. I don't recall hardly any that I followed. The outline of the whole problem, the general problem was to determine if in a large scale set up these metallic components would greatly inhibit the acid and to determine the effect that this lead plate in the Menaul process had contributed to that inhibition, or whether it contributed at all. And the decision to use the acid, we must have discussed, for I ran this Penn or our men ran this Penn Salt acid. That must have been discussed in one of these meetings or conferences we had, and here with two types of commercial acid, and then with Graselli's very close to us, and in my opinion it made no difference, practically, as to the finding of this work, the general findings, as to whether a considerable amount of lead and some copper in the acid would greatly inhibit—increase the inhibition of commercial acid when run through a pipe system. That I think we have done and I think is independent of a variation in some small percentage in the acid inhibition.

Q. I show you a letter under the letterhead of The Dow Chemical Company, addressed to you, "Re: Acidizing Contact Time" signed by Mr. J. Rebbeck, Patent Department. Did you receive this letter? A. I did receive it.

Q. Is this Mr. Rebbeck's signature? A. It is.

Q. Mr. Rebbeck is the witness who was here on the stand sometime ago in this case. A. Yes.

Mr. Lyon: I want to read this letter to the court. It is dated January 24, 1941. In reading it to the court I will ask the court to have in mind the Dow men were present at these wells where they have obtained these samples, so they have full information as to the facts that are reported in this letter by the Dow Company.

Mr. Lyon: I think I will offer in evidence the previous letter dated September 12, 1939, from Mr. Robinson to Mr. Prutton. With the understanding if you don't want to destroy the file, the reporter can copy it in.

(Whereupon the document above referred to was marked DX 221, and reads as follows:

"THE DOW CHEMICAL COMPANY
Midland, Michigan, U. S. A.

September 12, 1939.

"Dr. C. F. Prutton,
Case School of Applied Science,
Cleveland, Ohio,
Dear Dr. Prutton:

"We have already forwarded to you under separate cover data relative to the composition of Halliburton lead and that section of the depositions dealing with the layout of the truck tanks.

"As for the ratio of Pb area to Fe area and the composition of the steel used for the truck tanks, I am asking Conner to get this data as soon as possible. We should be able to get the Pb-Fe area figure without much trouble, but as to the other item there may be some delay. I assume that in the case of the steel analysis you are mainly concerned with the copper content, insofar as it will determine whether or not your tank produces an acid having approximately the same copper content as the Halliburton truck acids. (We have some experimental runs which show that the copper in the acid is derived from both the lead and the iron, for a well tubing—Halliburton Pb couple in 15% HCl.) In order to avoid having to duplicate the steel from Halliburton's tanks, we might substitute for Test Run C a run similar to B, except that the acid in the crock would be synthetic Halliburton truck acid, i. e., metals added, which would be run through the steel tank rapidly as in B in order to avoid further metal pickup. That is, the inventory in the steel tank would be kept just high enough to allow for siphoning and getting the electrical output of the

couple into the tubing, possibly a 20-gallon inventory or thereabouts. I take this to be what you have in mind for Test Run B. With this procedure, we need only be concerned with avoiding an excessively high copper steel. So far as I know the electrical output of the cell is not going to be appreciably effected by the usual variations in steel composition.

"The tubing you require can be purchased from the Oil Well Supply Company, which has supply houses at Pittsburgh, Oil City, Franklin, and Butler in Pennsylvania and at Wooster and Newark in Ohio. This tubing is made by the National Tube Company.

"Bartell has been using 2" API seamless tubing. The smallest tubing of this kind available appears to be 1¼" nominal (1.38 I. D.), but to get this under A. P. I. specifications it is necessary to take an external upset joint, which you will probably only cut off anyway to get steel samples. The specifications for this tubing are as follows:

"National A. P. I. External Upset tubing (quantity required), 1¼" (nominal), 2.34#/ft. with threads and upset without coupling, seamless, external upset, grade C. Specify length wanted.

"The same tubing without the upset and lacking A. P. I. recognition or approval is sold at National Oil Well Tubing, 1¼", 2.27#/ft., seamless, plain end, grade C. According to the catalog data, this tubing is the equal of the A. P. I. tubing as regards thickness, test pressure, tensile strength, bursting pressure, etc., and has the advantage of having plain ends from which samples may be cut off without sacrificing a special construction.

"Dr. Bartell has not indicated what grade (B, C or D) of tubing he is using. Usually when this is not specified, the distributor supplies grade C and I assume this to be the case here. I will confirm this as soon as I can reach him.

"Tubing is supplied in two ranges of length: range 1 averages 21 feet with a minimum of 20 feet and a maximum of 24 feet. Range 2 averages 28.5 feet, maximum of 32 feet,

minimum of 24 feet. Tubing will also be cut to length when so ordered.

"We would prefer to use the same commercial acid (General Chemical Company, Chicago) as was used by Halliburton in the well treatments with which we are concerned if we could be sure that the acid would have inhibition of the same order (10-15%) as the Halliburton storage acid. We have observed occasional high inhibition in this and other commercial acids. I should say that there might be an advantage to using Grasselli acid in that you would probably have a chance to check on the inhibition before buying it in any large quantity.

"We will arrange with Dr. Bartell to have him send you the corrosion strips for inhibition testing. It would be advisable, however, to cut off a small section (at least 4" long) from each pipe section that you use and to have the former cut up into corrosion strips which could then be checked against Bartell's material. In any event, it would be a worthwhile precaution.

"I am enclosing some notes and comments on the setup and tests which you propose to use. We hope they will facilitate the work and possibly help you to avoid some trouble.

"Very truly yours,
The Dow Cemical Company,
"Harold Robinson.

"cc:
C. A. Campbell.
L. C. Chamberlain."

The Court: The letter of September 12, 1939 as I understand it, is from Robinson to Dr. Prutton, is that correct?

Mr. Lyon: That is correct.

The Court: And the other one is January 24, 1941, DX-222.

(Whereupon Exhibit 222 was marked by the Reporter.)

Mr. Lyon: This letter of January 24, 1941, is addressed to Dr. C. F. Prutton, Case School of Applied Science, Cleveland, Ohio.

"THE DOW CHEMICAL COMPANY
Midland, Michigan, U. S. A.

January 24, 1941.

"Dr. C. F. Prutton,
"Case School of Applied Science,
Cleveland, Ohio.
Dear Mr. Prutton:

"Re: Acidizing Contact Time.

"Pursuant to a suggestion made by Mr. Owen recently to examine the data in the Halliburton reports on well treatments performed by them and observed by us, I have ascertained from their tickets the approximate time during which the acid introduced into the well was in contact with the well tubing and the rate of flow of the acid through the tubing. The following is a tabulation of the pertinent data, which is taken directly from the Halliburton acidizing tickets for three wells. I have added a column of figures entitled "Gallons per Minute," which is the average rate of flow computed from the time and volume of acid introduced.

"Stella Wilcox No. 3

Time	Vol. Acid In	Pressure Gasing	Pressure Tubing	Gal. per Minute
9:30 A.M.	Start	0	0	
9:35 A.M.	500 gal.	50	15	100
9:40 A.M.	1000 gal.	100	15	100
9:42 A.M.	1200 gal.	100	100	100
9:55 A.M.	2000 gal.	100	400	65
10:30 A.M.	15 bbls. oil	50	700	
11:00 A.M.	25 bbls. oil	0	600	

Zahn No. 2 (First Treatment)			
11:00 A.M. Start	0	0	
11:03 A.M. 250 gal.	75	20	83
11:07 A.M. oil.....	50	500	
(Second Treatment)			
2:30 P.M. Start.....	25	0	
2:35 P.M. 500.....	50	205	100
Crawford No. 5			
12:20 P.M. Start.....	0	0	
12:30 P.M. 600.....700		350	60
1:10 P.M. 1000.....800		475	10
1:55 P. M. 1500.....700		375	11
2:45 P.M. 2000.....700		375	10

"From the foregoing information it appears that the contact time could be computed as being the difference between the starting time and that at which the whole charge of acid was in the well, and this assumes, of course, that it takes about as long to fill the tubing with acid as it takes to empty the tube after the charge of acid has been put in, an assumption which may not be justifiable in all instances. On the basis of this assumption the contact times would be as follows:—

"Stella Wilcox No. 3—25 Minutes.

"Zahn No. 2 (First Treatment)—3 Minutes.

"Zahn No. 2 (Second Treatment)—5 Minutes.

"Crawford No. 5—145 Minutes.

"The lengths of the tubing in each of these wells were 2600 feet for the Stella Wilcox No. 3 Well, 2600 feet for the Zahn No. 2 well, and 2676 feet for the Crawford No. 5 Well. This was 2 inches 4.6 pounds Spang API lapweld Range 1 pipe, the I. D. of which is 1.995 inches.

"We are concerned as to whether or not the observed inhibition values in your experiments (which are computed on the basis of the relative amount of iron picked up by raw acid solution compared to that of Menaul acid solution in passing through the experimental pipe) would show substantial or similar values of inhibition if the time of contact and rate of flow and pressure were made to cor-

respond exactly with those involved in the foregoing well treatments. It may be desirable to perform some additional experiments wherein the flow rate and time of contact, and possibly even the pressure, exactly parallels one or more of the Halliburton treatments for which we have data. If under these conditions a substantial inhibition is found, the experiment would tend to prove the acid is inhibited in actual practice of the Menaul process in wells. Please let us have your views as to this.

"Very truly yours,

J. W. Rebbeck,
Patent Department."

Mr. Lyon: At the adjournment last night I had just read Mr. Rebbeck's letter outlining the times of the contact of the acid in the pipe, in the three wells that the samples were taken from; it has been referred to in the evidence here as his suggestion that you run experiments to see what you would find the relative inhibitions to be under those conditions. Now, the only experiment that you referred to, I believe, in your testimony, or that is covered in your reports, where you attempted to run the acid at a different rate than one gallon per minute, was an experiment in which during half the time you ran it faster, but I believe you had no measurement of just how fast, and you did not make any determinations. That is correct, is it not, Dr. Prutton? A. That is correct, but there was oil present.

Q. Now, I find in this book of correspondence a carbon copy of a letter dated February 19, 1941, addressed to Mr. Rebbeck, and signed in typewriting "C. F. Prutton." Is this a carbon copy of a letter which you sent to Mr. Rebbeck in reply to the letter that I read last night (showing the document to the witness)? A. Yes, that is a reply, and is—

Q. (Interposing): I will read it, and then we will discuss it. I will ask to have this carbon copy of the letter marked DX-223.

(The letter above referred to was thereupon marked DX-223.)

Mr. Lyon: DX-223 reads:

February 19, 1931.

"Mr. J. W. Rebbeck,
"The Dow Chemical Company,
"Midland, Michigan.
"Dear Mr. Rebbeck:

"Attached are three copies of report on all data accumulated by us on laboratory inhibition tests. Several questions raised in recent letter from you, may be answered by this data.

"1. What is the inhibition of Halliburton's storage tank acid diluted to 4.3% N concentration?

"Page 7, Sample 2, is diluted C. P. HCl in distilled water, yielding 78.9 grams iron per meter per hour rate of attack. Sample 3 is 4.36 N Halliburton storage tank composition showing 52.5 grams iron per meter per hour. Per cent inhibition is therefore $78.9 \text{ minus } \frac{52.5}{78.9} \text{ times } 100$, which equals 33. per cent."

I call Your Honor's attention that there is a determination by the witness that the Halliburton storage acid, on the basis of making these determinations, has a 33 per cent reduction in corrosion.

A. (Interposing): May I discuss that?

Q. (By Mr. Lyon): I will come back to this letter in a few minutes. A. All right.

Mr. Lyon (continuing reading):

"2. What inhibition would Menaul acid show if the acid treatment required as low as three minutes only.

"Page 8 and first paragraph $107.0 \text{ minus } \frac{88.}{107.} \text{ times } 100$ equals 17.8 inhibition in three minute test, since Menaul acid showed $72.5 \text{ minus } \frac{22.5}{72.5} \text{ times } 100$ equals 69.0 per cent inhibition in a three hour test.

"However, a three minute acid treatment would require high turbulence in the acid contacting in the tubing, thus differing widely from the static conditions in these laboratory tests.

"3. Comparison of analysis of Menaul tank acid with time of standing in special tank."

And I am not interested in the reading of that third subject at this time.

The Court: When he says Menaul and Halliburton, he is talking about the same thing?

Mr. Lyon: When he was talking about the Halliburton acid in the first place, he was talking about the tank acid, I mean the storage acid, storage tank acid, and when he talked about the Menaul tank acid he was talking about the transportation tank.

The Court (interposing): What I have is difficulty in just grasping the theory.

(The Witness): May I explain it? Did you want me to?

Q. (By Mr. Lyon): I will ask you, to give you an opportunity.

Q. In the first place, Doctor, you did not report this data in Exhibits 184 and 185? A. No, because we felt it not representative.

Q. And you haven't revealed it in your testimony? A. I have revealed in general, not the specific tests. No, I haven't revealed anything about the velocities.

The Court: I am trying to get the theory of that letter and I will ask the witness if this isn't true—those figures that they give, those three inhibition results, wouldn't that mean two things: First, we will say it would mean that by the Menaul test it did increase inhibition and the longer it stayed up to a certain point, the higher inhibition. Wouldn't it show that? A. One thing I want to be sure you understand and get straight. The time he gives there is the time of contact of the acid with the tubing, not in the Menaul tank, but the contact of acid with the tubing. I want that thoroughly understood first.

The Court: All right. Now, that answers one thing. Now the other conclusion I drew from it is that you naturally would draw the conclusion from that that it was added to the storage tank acid because it couldn't be lower than it was before it left. Is there anything you can put in to increase inhibition? A. It has inhibitors added by contact with the Menaul tank. This is the storage tank at the station now.

The Court: And that shows a higher inhibition, that three minute test? A. I think you have got to compare the same time of contact with the same time of contact. I would like to explain that contact.

The Court: In other words, there are two different kinds of analyses, the first one the Halliburton tank acid is an analysis, that of qualitative of the same kind of analysis by taking that and testing it and by putting some iron in it and see how much, in that way? A. That is correct, except that I did not analyze the acid. We made up a synthetic acid to duplicate some figures that Mr. Rebbeck had given me and stated that that was Halliburton storage tank acid composition. He thought that and he said run it in your laboratories and test.

The Court: Is this your letter? A. That is my letter.

The Court: Where did you get the 33 per cent? A. We determined that.

The Court: In what way? A. By taking this letter of Mr. Rebbeck in which he said it is .93 per cent or parts per million of copper and Halliburton's storage tank acid they figured so many parts per million of lead, which I don't recall, and of iron, and with the chemically pure acid, and added to it the amounts of those metals to make up a synthetic mixture, which agreed with this analysis that Mr. Rebbeck stated to me was this storage tank acid.

The Court: Did you get that by putting some iron down in there? A. And then we took that acid which we made and put one of these collars of 1¼ inch pipe into it for three hours in our standard laboratory test procedure and determined how much iron it ate off, and it showed 33 per cent inhibition.

The Court: Well, between you, if your figures were right, you determined that Halliburton storage acid, if you didn't make any mistake, and everything just as you did, if they had that whole tank to use, and could and did put some iron in it? A. If the analysis was correct.

The Court: All right. That was the way I got the idea as to how that came. Now, how did you get—you got the next by letting it run past the iron for three minutes? A. No, we immersed this collar of tubing into the acid for three minutes and then withdrew it and determined its loss of weight in this inhibition test. We took acid which corresponded to the Menaul tank acid. That is the acid such as was found leaving the Halliburton tanks as it went into the well, with a collar of about three to four parts per million of copper, and three or four hundred of lead, three or four hundred of iron. We made up a synthetic Halliburton acid.

The Court: The way I understand inhibitions, and your finding about a quality of the solution, isn't that it? A. It is not always a solution.

The Court: You are using inhibition in an unusual way if you are talking about how much it is inhibited for that use at a certain length of time? A. It is inhibited, but it is tied in with the metal, and a number of other factors in the determination.

The Court: Do you mean the same acid there you found on one acid 17.8 and another 16.903? A. Yes, sir.

The Court: The same acid? A. Except that the time—

The Court: They were poor tests? A. No, no.

The Court: What acid is inhibited to a certain extent when the other is put in? A. That is it. It isn't per cent inhibition, or I should say per cent inhibition is not a constant.

The Court: You are talking about how much inhibitor we can have in acid? A. That is true, but the time of contact and the factors of the nature of the metal surface—

The Court: I take a piece of some acid and I put it down into a well, it don't determine how much it eats it, it determines the quality of that acid, when I start to put it down into the well, doesn't it? A. That is correct.

The Court: That is what I am trying to get at. A. There is no way we have of getting a number which is independent of other variables that expresses that inhibition.

The Court: Given a certain piece of acid, is it possible that science cannot tell me whether it is inhibited—not only whether it is inhibited, but the percentage of inhibition? A. It is not possible to tell you exactly the percentage of inhibition.

The Court: I want to get at my fundamentals here. I supposed— A. (interrupting): The percentage varies.

The Court: I had supposed after all of the testimony I have heard, that here is a gallon, or a barrel, or a million barrels of acid, all in one container. Now, understand, I am not talking about how difficult it is to do the trick, but I had supposed that that acid was either inhibited acid, or it was not inhibited acid, independent of any use, except as to iron—why, it is hydrochloric acid, and it is either inhibited as to iron, or it is not inhibited. Am I correct? A. That is right, that is correct.

The Court: Now, I am not talking about how difficult it is, but I had supposed that there was some way to tell the percentage of inhibition of that acid over there, independent of its use. It is hydrochloric acid, and it is inhibited as to iron, I supposed—we have agreed now that it is inhibited, or it is not inhibited; and then I come over to percentages, and I have supposed that as to iron it was inhibited, say, 30 per cent, or 70 per cent, or 15 per cent, or some certain per cent, no matter how difficult it is to obtain it, or what method you used, I had supposed that that was a characteristic of that acid, that is, that it would be correct to say—without saying how fast somebody is going to move it, or where they are going to put it—that I could say that it is inhibited, say, 37.5 per cent? A. You cannot do that.

The Court: Then I have got a wrong conception of inhibited acid. This is now in the fourth week of this trial. Somebody will have to tell me what—somebody will have to explain, when you say an acid has a certain percentage of

inhibition, what it means. A. I think your concept would be all right if you would follow it just a little further.

The Court: I understand that it will eat more or less, depending on how fast it moves. But another man will test it and get a different result then?

Mr. Wiles: His may or may not be parallel. He may have different figures.

The Witness: That is not correct. If you have a condition constant, then you are going to get the same thing.

The Court: Certainly, but, you take the same tank, one man will drive farther than another with it, and another man will take the tank of acid, fill it up, and drive a mile with it and dump it out. But another fellow fills the same kind of acid into his tank, and lets it stand all night and drives twenty miles and dumps it out. One acid is inhibited more than the other acid is.

I have had a different conception of it. I have had the idea that one acid—as I say, they are both iron tanks, which is the same kind of acid, only one tank goes farther. I have understood all the while this difference in results. I have understood that if you take an iron tank and put, we will say, chemically pure raw acid in it, and drive for just an hour and dump it out, you would not eat your tank so much as you would if you put that same acid in a tank, and let it sit all night and then drive a hundred miles with it and dump it out. I understand that the second acid would eat more than the other, although they were just alike. But, I have supposed that you could say that those two acids were inhibited to a certain per cent, and they were just alike, one was just the same as the other.

Now, I have talked about pure acid, but I will take one that is inhibited, I will say up to 20 per cent—they are inhibited to 20 per cent, and I put the same acid out of the same vat into two different iron tanks, transportation tanks. One of them I let sit there all night, and I haul it the next day, and at noon dump it out. The other one I haul promptly and dump it out.

Now, I have supposed that those two acids were in-

hibited to 20 per cent. I supposed that that could be determined. I have supposed that the one, because it was a longer time in contact with the iron tank, would eat more than the other. But, now, I find that I must not say that those two acids were alike, and each inhibited to 20 per cent. I must say that one of them was inhibited a short time to a lower per cent than the other one. Now, that is a fine definition that we have got, that is all I have got to say, talking about acid. If you eliminate the use of it as applied to acid at all, and apply it to results, and say acid containing this, in that length eats so much, or is inhibited from eating so much, I can understand it. But you have been using this as applying to the acid, the quality of the acid. Now, you cannot convince me that the quality of those two acids was not just the same. I have taken them out of the same tank, put them into two different iron tanks, and their inhibition was the same.

Mr. Wiles: Certainly.

The Court: And characteristic and strength and vitality, and if you want to apply this term to them you ought to work out some way of using that so that it wouldn't be so confusing as it is to say that one is inhibited to a great— you say one is inhibited to greater strength than the other, although I dip them out of the same tank? A. No. When you say per cent inhibition, I mean the time of contact which I ran the sample, the metal that I used, the temperature.

The Court: You are talking about results then, aren't you, and not about your acid? A. Absolutely.

The Court: Then apply inhibition to results and not to your acid, if it doesn't apply to the acid, am I not right about that? A. No.

Mr. Wiles: That is like every other thing.

Mr. Lyon: I should think the witness ought to answer first, because I don't know what the testimony of the witness is going to be.

Mr. Wiles: We have these material tests made by the A. S. T. M. and every one of them you adopt a standard test. We have an anti-knock test. You have got that test

in a standard engine, or it don't mean a thing. There is 78 octane gasoline and 72 and it means a definite thing, but it is only 78 if we try it in the standard engines at these times and temperatures.

The Court: Per cent of inhibition doesn't apply to the acid, does it?

Mr. Wiles: Just as much.

The Witness: Not solely to the acid, not entirely, but it applies to a considerable degree to the acid under definite conditions.

The Court: You are talking about a result, aren't you, when you say degree? A. Well, the result is what you measure.

The Court: You have got two acids that are just alike, you dip them out of the same thing, and you use them differently to get different results, don't you? A. Yes.

The Court: If there is a different percentage of inhibition in your acids— I dip them out of the same tank,—I use them different and of course I see that, don't think I am so dumb I don't see it get different results, but is there a difference in the acid in percentage of inhibition? A. Not fundamentally when you get back to the acid alone, unless you have these stipulated things. It is just a common practice, a method of measuring the reduction of corrosiveness of acid to specify under what conditions you run that test.

As Mr. Wiles explained, we say gasoline is 78 octane rated, and I think if you want to define that you would say that is an exact number, and that depends on the gasoline, and you could say, yes, it does depend on the gasoline, but when you describe that number you have to tell the dimensions of the engine, the temperature of the air, the exact, specific method of measuring that, and give about 101 different details, instead of five or six.

The Court: Well, if I want to measure something I recognize that you can standardize it and say that whenever we use that we refer to these specific conditions, and if you would only say or understand that we will say gasoline is of a certain test, or you can say what the temperature is,

so and so, and pressure is a certain thing, and other conditions, I recognize go in to make that which is standardized, and you can do that. If you don't, then I don't see how you can apply percentages to a particular mixture I have. You must go over to your results obtained, in my judgment. A. That is exactly what has been done here, I believe. We have reported per cent reduction in corrosiveness under specific conditions of test, and the question is whether the conditions of test have been in any way valid.

The Court: Now, I am not talking about results to defendant, because I think I understood all along your theory about that. We are just talking about what people mean when they say things. That is all the way this becomes important here on this record. You will find a lot of things have been said already about percentage of corrosiveness and comparing it with some other, to percentage of corrosiveness.

Now, does the defendant agree with the plaintiff that this term as applied can't be used at all unless you state what the conditions—that you can't tell the percentage of corrosiveness of a particular mixture that you have, and you can't be certain as to so many percentage of corrosiveness, or inhibition?

Mr. Lyon: We agree with that, with this meaning, that unless you specify all the conditions which would materially affect the value of the percentage, all those conditions which existed in the test, then your figure has no meaning at all.

The Court: Then you never could speak of an acid that is in a tank as being a certain percentage of corrosiveness, or a certain percentage inhibited.

Mr. Lyon: In other words, Your Honor, just to make it very simple, and take one factor, these results which they have charted here with these comparative charts only show these differences in percentage which would exist on a three hour test. They wouldn't—this chart wouldn't be the same if for some substantially different time, would it, Doctor?

The Court: I recognize that.

The Witness: I don't think it would, no. We haven't claimed it would.

Mr. Lyon: In other words, we don't care whether the acid is in there for three hours or for three minutes.

The Court: We never should say an acid is a certain per cent inhibited and stop there.

Mr. Lyon: That is right.

Mr. Owen: In order to show that this acid is inhibited we have conducted two kinds of tests. Dr. Bartell first conducted tests in which he took defendant's actual acids from their storage tanks and from their truck tanks, and he compared them, he tested them under similar conditions as to time, temperature, size of test piece and amount of acid, and he found that under those conditions the truck acids were inhibited much more than the storage acids.

The Court: Depending on how much they ate; that was all, wasn't it?

Mr. Owen: And another thing he did, in order to see what the effect of these small amounts of copper and lead and iron had, he made synthetic acids in which he started with C. P. acid and added these metals to that, and then he compared the corrosiveness of the C. P. acid with that of the synthetic acids under similar conditions.

Then Dr. Prutton took up the work, and Dr. Prutton also conducted two kinds of tests. First he conducted laboratory tests in which he followed generally the methods followed by Dr. Bartell, in which he made synthetic acids by adding to chemically pure acid these different kinds of metals.

The Court: Yes.

Mr. Owen: And he tested the C. P. acid and the synthetic acid, side by side, under similar conditions. Then, in order to come closer to actual field conditions he built up this apparatus which he has described, and he tested the Halliburton acids against commercial acid purchased from Grasselli Chemical Company, and he took a different standard. He did not take the C. P. acid. He took the commercial acid. And then he did two things. He built up

that commercial acid synthetically by adding metals in amounts comparable to those found in the defendant's acids, and he tested those through this apparatus, running it from a stoneware crock where there could be no change except that which took place in the pipe, and then he went further and he built a tank to simulate the Halliburton tank, and he put commercial acid into that tank and let it stand there for six and a half hours, and stirred it every fifteen minutes, so as to get as nearly as possible an acid that would have resulted had the commercial acid been carried in a Halliburton tank for six hours.

Then he ran that acid from this simulated Halliburton tank through the system, and he analyzed it to see how much copper or how much iron there was when it started through the piping system, and he analyzed it to see how much there was when it got through, and he took the amount of iron that was taken up from the pipe and compared that amount with the amount of iron that was taken up from the pipe with the commercial acid, without any additions, run from the crock through the pipe.

The Court: You take a given acid, and you run it for three minutes, you get a different inhibition than you do if you take the same acid and run it for three hours, don't you? A. That is correct. I have a chart of the inhibition against time, Your Honor.

The Court: All right. I follow that. Now, we will say you get 17.8 if you run it three minutes, and we will say that you get 69.03 if you run it for three hours? A. Yes.

The Court: Is it correct to say that acid is acid of a certain per cent inhibition, and say nothing more? A. No. We have got to describe the tests, and we have tried to do that.

The Court: If you put it in an iron tank and haul it for three minutes, you get a different result than you do if you put it in an iron tank and haul it for three hours? A. You get a different result.

The Court: Would it be correct to say that the acid

you put in a tank had the same inhibition, and stop there? A. The acid is the same.

The Court: I know. Now, don't misunderstand me, I am just talking about how to talk about this thing, and how we have been talking about it, and get it on the record. I understand exactly now that it is going to eat more, the longer it is in there. I understand there are other things entering into it. I want to know whether it is correct to say that the acid had the same percentage of inhibition, if you put one in a tank and haul it for three minutes, and you put the acid in another tank and haul it for three hours. Is it correct to say—is it correct to use that term, that it has got the same inhibition? A. No, I would not use it. I would describe how long it was in the tank.

The Court: Well, in this record you will find that that is done. I am trying to get it clearly on the record, but you can't use that expression with reference to acid. It is only when you state all of the elements, according to your testimony, is that right? A. That is correct.

The Court: It depends, too—you take the same acids, and you take different kinds of iron—you go to two different places and get iron, and you put one into one vat of this same acid, and you put the other into another vat of the same acid, you get different results—your iron is different? A. Somewhat different, yes.

The Court: Then it is not correct to say that you take acids of the same percentage of inhibition, is it? A. No, not without explaining the tests and the results.

The Court: They have got different inhibitions, because you have used them differently? A. The popular conception of the term "inhibition" is—

The Court: Oh, I know, but I want to know just how wrong we have been in using the definitions here. We should not apply it to the acid when we get to percentages. You can say it is inhibited, that it is capable of inhibition? A. Yes.

The Court: But when you get down to percentages, you must not say it any more, is that right—we must stop

using it? A. With reference to a certain figure. You have got to define conditions, and the popular use of the term "inhibition" is an erroneous one.

The Court: Well, I take my acid, and I haul it in a wooden tank, nothing else touching it, only the wood—what is its inhibition? A. If I am to answer it, the way I would report inhibition—

The Court: Now just wait a minute. I did not take it out, I didn't do anything with it. A. I would say that you would have to take the acid out of that tank.

The Court: But I didn't take it out. You can't take it out of that tank. I have put it in there, and I keep it in there twelve hours, and I haul it all around. Now, I want to know whether it is inhibited, or not. A. And you take some out and test.

The Court: You have got to take it out and put it in with iron? A. Absolutely.

The Court: Then you can't tell how much, except that you state how long and whether it was agitated. They are just as necessary as those who describe the acid. A. Not quite.

The Court: How can you state percentages, one without the other elements? A. You can't.

The Court: If you keep it in the wood and don't let it touch anything else, what is its inhibition? A. You have got to run a test.

Mr. Lyon: The percentage of inhibition you get by that test will be different if you have two different kinds of iron that you tested on? A. It will be somewhat different.

The Court: All I am bringing out is now that the way we have been using the percentages don't apply to acid and the stuff that is in it. The percentages apply to the acid, that stuff that is in it, the time that is used, the agitation, and all the elements that figure into it, and it is only as to those results, in other words, that it applies, and that result and that percentage in the result is contributed to, I understand that fully now, and you don't need to worry about that, it is contributed to by the acid and it is con-

tributed to by the time, but whenever you use the term percentages you are talking about results and not about the things that go in to make the result. A. That is involved in it, but it is not the sole factor.

The Court: But you mustn't apply the percentage over to time? A. No, sir.

The Court: You mustn't apply percentages over to agitation? A. No, sir.

The Court: You mustn't apply percentages over to the acid? A. Not alone.

The Court: Not in inhibition now. Of course, you couldn't apply it all the time? A. You have got to take them altogether.

The Court: But when you come over to talking about percentage of inhibition of corrosion I must not apply that to the acid at all, and I must not apply it to whatever is put in as an inhibitor. All right. Now, we have got that, I think, clear on the record. A. It is a method of comparing acids under similar conditions, and that is all. I would like to answer the questions raised in that letter.

The Court: You mustn't say an acid is a certain per cent inhibited because no chemist is wise enough to determine that. Doctor, given a quantity of acid, you can't analyze that. A. Not without specifying the conditions. We can analyze it chemically.

The Court: Yes. But you are dealing with a proposition and you have used the definition as such after you have analyzed that you can't say it is a certain per cent inhibited. A. Not unless you make tests.

The Court: And then you get results depending on the condition. A. And comparison of one solution with the other.

The Court: Then it isn't comparable. Most things you take an analysis, you tell how much it is with this percentage. A. We have these chemical analyses. We say there is 1% lead. We determine absolutely. That is fixed on the sample.

The Court: Yes, I get that. You tell me the in-

gredients in it but when you talk about per cent inhibition you are not talking about the ingredients. A. No, talking about the performance of it under a definite test condition.

The Court: Then why don't we agree you are talking about results and not ingredients. Don't you agree with that? A. The ingredients contribute.

Mr. Lyon: All right, doctor— A. (interposing): May I explain the letter? We got sidetracked on the discussion.

Q. I will finish my part in a few minutes, and I will give you an opportunity then to explain, or they can.

The Court: I want to give you a full opportunity, doctor. A. Yes.

Mr. Lyon: I am going on with this, and it is not going to interfere, at all, I am sure.

Mr. Lyon: Doctor, when you reported the results of your tests to the Dow Company, you simply reported, did you not, the actual values that you found in the first instance? A. Why, I believe so. I always report results as to what I find.

Q. I mean the result, the measure—

Mr. Owen (interposing): I suggest that the witness be shown the letter that you are referring to.

The Court: Yes; he is entitled to see it.

Mr. Lyon: Yes, if there is anything he wants to see. A. What are you asking about?

Q. I am asking a physical fact now. A. The physical fact is that I report to a client sometimes in letters and preliminary statements, I report preliminary reports, and then finally when I get through summing up all the work that has been done, I arrive at some definite conclusion as to the results of the work and I report that. It has been referred to in the correspondence here.

Q. What I am getting at is this, doctor, these tabulations, such as PX-189, of the kind that were brought here, you did not prepare those at all? A. No.

Q. They were prepared by the Dow Company? A. Yes, that is correct.

Q. You were asked to include them in your report? A. Not in my report.

Q. In Exhibits 184 and 185? A. Well, it is not bound in my report. They brought those charts in, and we checked the figures on them.

Q. Now, doctor, the various tables that were included in your report, those were also prepared by the Dow Company, were they not? A. Absolutely none of them. They were all prepared by us.

Q. You prepared these reports and submitted them to the Dow Company, but as they appear in Exhibits 184 and 185, they have been completely re-written from when you first presented them to the Dow Company, have you not? A. I presented interim reports, by just reporting whatever came at hand, to try to give them a picture, and letters were written as to little changes that might have been made, or little differences.

Q. You say they were only little things. Weren't you asked to leave out some things? A. There were a lot of small tests that were made, of various kinds, and in making the final report that was brought in here, and which I don't think we submitted as a display or an exhibit, but was taken in as an exhibit, that was written, specifically going at one particular object, not to include all of the little miscellaneous things that we arrived at on the side, or—

Q. (interposing): I am going to ask you if this is one of the letters that you received from Mr. Rebbeck with reference to the data or the report after you had submitted it. This is dated July 18, 1941, addressed to you, and signed by Mr. Rebbeck, on the stationery of the Dow Company (handing the document to the witness)? A. That is a letter that was sent to me, and we revised the report in line with this, and, as I recall, before that letter was written to me, I had had a brief conference with Mr. Rebbeck in Midland, in which he just went over this, there were a number of typographical errors, and we went over the form in which the final report was to be prepared.

Mr. Lyon: I will ask that this letter be marked DX-224.

(The letter above referred to was thereupon marked DX-224.)

Mr. Lyon: I will read this to Your Honor, it isn't long. I will read the first part of it.

"DOW CHEMICAL COMPANY, July 10, 1941.

"Dr. C. F. Prutton,

"Case School of Applied Science,

"Cleveland, Ohio.

"Dear Dr. Prutton:

"Subject: Changes in 'Memorandum reports on Halliburton-Dowell case' June 20, 1941.

"Mr. Owen has reviewed the subject report and would like the following changes made. Will you please retype the pages to be changed and furnish us with copies for our reports?

"The changes to be made are as follows:

"First, number all the pages beginning with the title, 'The Effect of Pressure on the Corrosion of Steel by 15 Per Cent Hydrochloric Acid containing Inhibitors,' but omitting the memorandum of report entitled 'The Effect of Crude Petroleum Oil on the Corrosion of Oil Well Tubing by 15 Per Cent Hydrochloric Acid.' With this section omitted, the title page 'Small Scale Tests That May Be Used To Demonstrate the Effect of the Menaul Process' will be numbered 5.

"Revise the table of contents by omitting the second item, namely, 'The Effect of Crude Petroleum Oil on the Corrosion of Oil Well Tubing by Fifteen Per Cent Hydrochloric Acid.'"

Then there follow several pages of changes. I guess I will have to put them all in, as the witness has attempted to deny the latest report in existence that this letter mentions.

Q. The first of these letters asking you to revise your report, and also stating—I think I will read the letter so you can identify it. This letter is dated July 9, 1941, from you to Mr. Rebbeck, is it not? A. From Rebbeck to me.

Q. You received that letter, did you? A. Yes.

Q. I will ask that this be marked DX-225.

(The letter above referred to was thereupon marked DX-225.)

Q. The next letter is—well, on the same subject there is another letter of the same date, is there not? A. Yes.

Q. You received that letter? A. Yes, I received that letter.

Mr. Lyon: I ask that this be marked DX-226.

(The letter above referred to was thereupon marked DX-226.)

Q. The next letter is the letter that I have already read, which is DX-224. I have already read that. The last letter is a letter dated July 11, 1941. Did you receive this letter from Mr. Rebbeck? Did you? A. Yes, sir, that is correct.

Mr. Lyon: This will be DX-227.

(The letter above referred to was thereupon marked DX-227.)

Q. With reference to these letters, or this last letter, DX-227, that is the letter in which Mr. Rebbeck suggested to you the use of average of averages, and the averaging of various tests for determining what 100 per cent corrosiveness is, and the various matters that are involved—he worked out this per cent of corrosiveness and asked you to adopt it. You didn't do that, isn't that correct? A. As I said, as I recall I met Mr. Rebbeck some time in June, and I think Mr. Owen was there, and Mr. Conner, and these changes were discussed, and this method of representing the results. These are not any faked-up results. It is just a different way of writing the results, changing from per cent inhibition over to this reduction in corrosiveness, a different way of expressing the results. I saw no valid reason as to why it could not be done, and they said, "We will calculate your results, and you check them, and we will have the figures made up for you." And that was the way it was done.

Mr. Lyon: I don't think that it is necessary to read each of these letters if they are here, Your Honor, except

I will indicate as to DX-225. It says: "Subject Correction to Report Entitled Large Scale Test of Menaul Method of Acidizing Oil Wells dated June 20, 1941. Mr. Owen has reviewed the subject report and proposes that you make the following corrections or changes and that you retype each page requiring such changes or corrections, furnishing us with the retyped pages for each of the copies of this report." And then there is tabulated as to what he wants done.

DX-226 starts out the same way—"Subject Changes to be made in the report entitled Corrosion of Oil Well Tubing by 15% hydrochloric acid June 20, 1941"—these changes are made after the date that appears in exhibits 184 and 185. The date of the report is June 20, 1941. "The following changes are proposed as a result of the review of the subject of this lawsuit"—

The Court: When did we start this lawsuit?

Mr. Lyon: July 21st. Then the letter contains 2½ pages of changes. I have read from DX-224. DX-227 is the last one, dated July 11, 1941, and reads: "Dr. Prutton, for the purpose of constructing charts, summarizing your findings as to the corrosiveness of commercial hydrochloric acid to which you added iron, lead and copper, I have made some calculations reducing this data to relative corrosiveness as follows"—and then includes preparation of these things. I mean his method of calculating these things. This is signed by Mr. Rebbeck to this witness. The letter concluded: "It will be desirable for you to be familiar with the origin of the figures appearing on the proposed charts, and for that reason I have given you the methods used in computing them. In addition, there is enclosed herewith a typewritten form which will represent substantially the layout of the completed charts. I believe you should check the computations to be sure that the figures are right. If you find any errors, please immediately advise. Mr. Rebbeck, Patent Department."

Now, the purpose of this is so Your Honor will understand and distinguish in this testimony between what was

this witness' experimental data and what is the form in which it is reported, and whose idea and whose responsibility the form of the reporting is.

I think that is all the cross-examination.

REDIRECT EXAMINATION

By Mr. Owen:

The Court: Now, Mr. Owen, don't forget to give the doctor the opportunity that I very earnestly promised him.

Mr. Owen: I will try to, Your Honor.

The Court: I want him to have every opportunity.

Mr. Owen: With the character of the cross-examination, Your Honor, it makes it necessary for me to review to a considerable extent what Dr. Prutton did in preparing his work in connection with this case.

The Court: I will leave that to you.

Mr. Owen: I am going back to the time when the matter of this work was first referred to you, Doctor. Can you tell about when that was? A. The earliest recollection I have is late in the summer of 1939.

Q. And was that in a conference or by letter, do you recall? A. Just in a conference and discussion with Mr. Chamberlain and Mr. Rebbeck.

Q. And thereafter what, if any, tests did you make prior to the time you made these pipe tests in which you built the duplicate Menaul tank? A. Well, I made no tests before we started in on this large scale work. The discussion that I had with Mr. Rebbeck and Mr. Chamberlain was that in connection with this case that Dr. Bartell had certain things to perform, and one of the jobs that somebody had to do was to make something other than a little piece of steel in a beaker, and run some tests to indicate what would happen in an oil well tubing under conditions that should be fairly well reproduced, and reported, and that would fairly well represent what might happen in running down the tubing of an oil well, and that these tests also should include an examination of just how this Menaul

process functioned, and what part of the reduction of corrosiveness was due to the Menaul process.

Q. Well, now, in your direct examination, you referred to three different kinds of tests, as I recall. Two of them were laboratory tests, one set of which used little strips of iron, and in the other set of which you used one-inch sections of this same oil well tubing which you used in the larger tests. Now, in respect to time, what was the relation between your laboratory tests and your large scale tests? A. The laboratory tests that we finally adopted, and which are reported in the report as being comparable with the large scale tests employed a time of three hours for the test, and the time of the large scale tests was three hours.

Q. Well, that is not exactly what I had in mind. I am trying to get fixed in the court's mind the relative dates on which you conducted these three different series of tests. The two laboratory series and the large scale? A. Well, we started in to run the large scale tests and—those were the first tests we ran—and associated with the large scale tests we started testing the inlet acid with this laboratory test, using a very small specimen of steel and a very small volume of acid for a very long time of contact, thirty hours.

Q. And then, as I understand it, your first laboratory tests were made in connection with the acid you were using in the large scale tests? A. That is correct.

Q. I see. Now, before you started this large scale test work, did you outline any program and submit it to the members of the Dow organization who were interested in this matter? A. Following the first talk that I had with—there may have been more than one with Chamberlain and Rebbeck—they had indicated about in general what their problem was and they questioned whether Dr. Bartell, with the time available, and so forth, would be able to get around to make these large scale tests. I think they had that in mind when I first talked to them, that he would do the large scale work and the small scale work as well, that is, the analytical work. And, as I recall, they expressed some doubt as to whether he would get around to do it. And I

said if they wanted me to and thought it advisable that I would be glad to undertake those tests. And at the final meeting of those preliminary discussions they said, "Well, you write up what you think ought to be done and let's talk it over again."

And I wrote that up and that is included in this complete file of correspondence, a complete outline of what I thought ought to be done to examine, to ascertain and determine the reduction in corrosion caused by copper and lead in acid, in passing through a piping system, in determining whether the Menaul process had any effect on reduction in rate of attack of acid upon steel, whether the effect you obtained with a Menaul tank was a combination of the inhibitor effect plus the Menaul effect.

And the tests that were outlined included first a running of blank or fifteen per cent commercial hydrochloric acid through a fairly good length of oil well tubing. Second, to run the fifteen per cent acid into this simulated Menaul tank, agitate it for some time that would roughly approximate what agitation would be obtained in handling the acid from the storage tank to the well, and then operate the Menaul process on that acid, that is, to deliver the acid into the tubing and connect the wire up from the tank to the tubing and see what effect that had upon the rate of attack, whether it was reduced over the raw acid that went in without the Menaul tank.

And the next type of test was to run the acid from a stoneware crock directly into the Menaul tank and immediately out, so that we would eliminate this inhibitor effect and we would get only this electrolytic effect, the Menaul method of inhibition, electrolytic inhibition, acting to stop the acid from attacking the tubing.

And the last test was to be a test in which we would take fifteen per cent hydrochloric acid and incorporate into it the metallic concentrations which the acid had when it left the Menaul tank in the Menaul test and we would run that acid directly from the stoneware crock into the tubing.

Those tests were all outlined. And at the beginning of

the work, at another visit to Midland, that proposal was discussed and, as I recall, Chamberlain was the only one present then. He may have talked to Rebbeck. But he said go ahead with the work, and so we went ahead. The first thing that we did was to purchase a number of lengths of this oil well tubing. We purchased a convenient size stoneware crock which was about 250 gallons, and which was so big in diameter and about so tall (indicating), about four feet in diameter and maybe four feet tall, and we purchased the smallest size of oil well tubing simply so that we could get a fair rate of flow of acid in the tubing.

If we used two inch tubing or three inch tubing the acid would have been very slow in running through that tubing, and then the inch and a quarter was taken as the smallest standard commercial oil well tubing that we could obtain.

Now, we had in mind at the beginning of these tests that if we purchased the tubing from one lot of tubing that the attack would be fairly uniform. That is, that if we had one length of tube here with acid running through it it would attack that length at a certain rate and the next length would be attacked substantially the same. And we proposed, with that in mind, as I recall, we purchased 30 tubes with the idea of using 5 tubes in each of these 5 different tests, and then have some tubing left over for making elbows and connections and to cut up for inhibition tests, and so forth.

Q. May I interrupt you there, Doctor. The tests that you outlined in your testimony were five in number—the ones that you outlined as you have just described them? A. There was a raw acid, there was a Menaul process, there was a quick Menaul process in which we ran the acid immediately in and out, there was a Menaul without the wire connected, and there was a synthetic Menaul type acid—five different tests were proposed.

Q. And your original plan was to run each of those tests in a separate set of tubing? A. In a separate set of tubing. We thought the tubing would all perform exactly the same.

Q. And you originally bought enough tubing for the five tests? A. To run the five tests and have enough left over.

Q. Now, will you go on with your explanation? A. Now, we knew, of course, we had to adopt some fairly standard conditions of running the test and we had heard, as I recall through Mr. Rebbeck, that tests were being made at 85° F. by Dr. Bartell in inhibition, and it seemed to us it was a fairly good temperature to use. I don't think it was given any great amount of consideration because it seemed like a reasonable temperature and one we could obtain fairly readily in our laboratory. The tubing, the temperature was fixed in that manner, the volume of acid was fixed by this stoneware crock we had, and we simply arbitrarily decided that we would run through a gallon a minute and would get a test of about 3 hours.

Now, if you question the condition as to the three hours, one of the letters introduced here indicates that I knew the acid treatments that were made by these people were 3 to 25 minutes, or 6 to 25 minutes, but I knew that after the program was about 50 to 60% completed and I couldn't go back and do that over. There were many reasons why I couldn't do that over.

Q. Doctor, aren't you misquoting that letter? A. I don't recall. It was a short time.

Mr. Owen: It is set forth in one of these letters, I believe, and I want to get that right. Yes, it is set forth in the letter dated January 24, 1941, to you from Mr. Rebbeck, which is in evidence as DX-222. Now, in this Exhibit DX-222, the times are given as follows, summarized: Stella Wilcox No. 3, 25 minutes. Zahn No. 2, first treatment, 3 minutes. Zahn No. 2, second treatment, 5 minutes. Those were both one treatment, Your Honor. It was two sections of one treatment. Crawford No. 5, 145 minutes.

Q. Well, now, will you proceed? A. I did not pay a great deal of attention to that letter, simply because we had filled out most of our program on three hours, and I had felt that taking a three hour result would get approximately

what was done in shorter or longer times. We knew that we could not run a three minute test, because we got this peculiar effect of loose powdered metal that we could not remove from the surface, that came out during the first few seconds of the run, and we got a peculiar result there that we could only explain by imperfect cleaning of the tubing. On a run of a 3 minute test, the acid is actually—one particle of the acid was running through our tubing, and taking 10 minutes to go from the inlet to the outlet, so that it would be impossible for us to run a 3-minute test and get any significant values.

We did, however, study quite thoroughly later in the laboratory the effect of time upon the rate of attack of the acid upon oil well tubing, but that came later, and that came after Rebbeck's letter about the time of contact.

I knew nothing about the time of contact before that time, and the basis of the three hours was simply knowledge—I had been out on acid treatments, and hung around for six to eight to twelve hours waiting for the acid to go into the formation, and the general knowledge that I had of the various time that acid treatments required—I had that general knowledge, and the three hours seemed to be a fairly reasonable figure, and fitted in with the equipment that we had, the volume of the crock, and the diameter of the tubing.

Q. Doctor, I show you a carbon copy of a letter dated January 28, 1941, addressed to J. W. Rebbeck, and signed in typewriting by C. F. Prutton. Will you state whether you wrote such a letter? A. I did write this letter.

Q. And state whether or not that was in reply to Mr. Rebbeck's letter of January 24, 1941, which is in evidence as DX-222? A. That is in answer to his letter in which he mentioned the short times of contact.

Mr. Owen: Now, I will ask that this letter—

Mr. Lyon: May I see it?

Mr. Owen: You had it. It was right in a bunch of letters you had this morning.

The Court: PX-228 this will be.

(The letter above referred to was thereupon marked PX-228.)

Mr. Owen: Will you explain that letter, reading such portions of it to the court as may be necessary to explain the sketch that it contains? The date is January 28, 1941.

The Court: With such a short letter you might read it all.

Q. Read the whole letter.

The Court: And then explain it. A. (Reading):

"Dear Mr. Rebbeck:

"Our 3-hour tests duplicated fairly well the time of 145 minutes required on the test on Crawford No. 5.

"However, we have no large scale tests made in from 3 to 5 minutes such as occurred in tests on Zahn No. 2. Moreover, we cannot see how a 3-minute test could be made with our set-up. However, our laboratory tests show that during a test of short duration, such as 3 to 5 minutes—"

we took this and put it only for a few minutes into the acid to see how the amount of iron dissolved compared with what would dissolve if we used the chemically pure acid—

"* * * the percentage inhibition would be about the same as would be obtained in the 3-hour test.

"The rate of solution of the iron is greater in the short test than in the 3-hour test."

The Court: You better read that to me. A. I will read the whole thing.

"If you think that test on our laboratory tests which we have shown to agree quite closely with the large scale 3-hour tests would be sufficient we will re-check our preliminary figures and short-time laboratory tests to more exactly establish the above curves. If you think it imperative to run large scale tests please advise me and we will attempt it."

The Witness: Now, the letter shows a drawing, or a graph, which shows plotted horizontally the time of contact in this laboratory test, 180 minutes, which is out at the end of 3 hours. The rate at which the acid ate into the steel, expressed in grams of iron per square meter per hour is plotted vertically. And it shows that in the first few minutes of the 180 that there is a peculiar sharp dropping of that curve.

Q. What does that indicate? A. That indicates to me that that is that loose metal which we got on our large scale runs, or metal which is highly disturbed on the surface of the steel that simply wiped off by the first acid attack, and it is difficult to run a test of such short duration to get a valid answer. As soon as you go to a period of 8 to 10 minutes, then the curve becomes almost flat, and they show, the upper curve uninhibited 15 per cent C. P. hydrochloric acid.

The rate of attack of that is about 70 grams per square meter per hour and it eats into the steel at that rate. The rate of attack of the same Menaul acid is about 25, in other words, about one-third the rate of the inhibited acid.

In other words, going from 8 minutes out to 130, and we in subsequent work that is in that book that we had, our data book, we went out for 12 to 14 hours too, and those lines just kept on going out. We believed that that would fall off when you went out to a considerable number of hours, but from the period of 8 to 10 minutes and going on out through our 3-hour test, the reduction in corrosiveness, of the Menaul synthetic acid was only about one-third as corrosive as the diluted C. P. acid, and therefore this letter, I believe, convinced Rebbeck, or at least I don't recall he wrote me another letter telling me to go ahead with large scale tests. This indicated the impractical nature of it, and also that we were running short of time, and so forth, and I don't recall any other correspondence on that. That seemed to close the matter up.

We did run checking values to check these preliminary data that we have, and we have data that will establish the curve from three minutes on out to fourteen hours or so, and the curve is substantially of that shape, showing that the reduction in corrosiveness is substantially constant after ten minutes time, and we believe that that first part is due mainly to these little particles of iron that when we run our wire brush through the steel that those little particles of iron are just held on there by a thin piece of connecting iron or something, and any attack at all loosens it

up. We got a slug with highly concentrated iron out of the large scale tests, indicating that to be true.

Q. Go ahead. A. That time was one of the conditions of the test. Then we realized that the method of cleaning the tubes undoubtedly would exert a great effect upon the test results. In other words, the scale, and so forth, on the surface, that we had to adopt some standard procedure, and so in Test A we set up five lengths of tubing with an extra part to connect it up to the top, and then coupled it, and we had—we purchased this stiff, hardened steel wire brush, and fastened it on the end of a long iron rod, and one of the operators that was to make this test, one of them was assigned to the job of cleaning out this tubing, and after he had done it he insisted that we put another man with him, or two other men, and we used three men to get that brush, which is, when extended, about two and a half inches in diameter, to ram that through an inch and a quarter tubing. It was a stiff wire, almost like piano wire, and it took two or three men to get that through and to do it in a reproducible manner. But he finally got it through and ran it through twice, which was the number of times that we used in later tests in the remaining use of the tubing.

Now, the rest of the method of the cleaning was essentially the same as we used in subsequent runs, but he just took a tremendous length of time and was all tired out after the cleaning out job, and, therefore, we later assigned two or three men to that, and we didn't feel particularly perturbed about the test because many things happened during that test.

In running the acid out of the crock, and coming down into the tubes, we left a vent there that would extend up above the level of the acid in the crock, so that any hydrogen generated or liberated by the attack of acid on the tubing would bubble back up and come out of this glass tube, and what happened was that it was like a fountain, that the bubbles would come back and the acid would squirt up into the air, and it scattered over the equipment, and I don't know how many gallons of acid were lost in the test, pos-

sibly one or two, but it made kind of a mess. So we had to modify the equipment in that respect.

The other differences in Run A were the shape of the tubing. There was one welded fitting which made two of the pieces of pipe welded together, which we never used in any other run later on, and we used—we numbered each tube we purchased, and we used tubes 1 to 5 to run A and we never used those tubes again in any other subsequent runs.

Q. Will you identify that run with the five runs that you have outlined in your program? A. That run was supposed to be a blank run, or a run of raw commercial acid through the tubing.

Q. And what letter was given to that run when it was made? A. In our data book, it was given the letter A, first run.

Q. Can you show to the court the set-up of the tubing used in that run? A. Yes. If I may have that preliminary report? It was not included in any subsequent reports.

(A volume was handed to the witness.)

Q. Will you just explain how that set-up differed from the one that was later adopted and used in all of the tests referred to in your report, in your final report? A. This had four lengths of straight tubing, and subsequently we used five lengths of straight tubing—is that correct, Mr. Lightfoot?

Mr. Lightfoot: Yes. A. But we had this peculiar bent piece of tubing here, (indicating), which we hooked up. Oh, we did not use that tubing for any further work. We then went to this set-up which involved the lengths of tubing and this long length of tee here (indicating). We could use that with Menaul test tanks as well as the other types of tests which we ran directly from the stoneware crock (indicating). This is glass tubing down around this here (indicating). There is a rubber stopper connected on to that (indicating). This elbow at right angles was used in subsequent tests.

Mr. Lyon: I think this had better be marked, the first one that you referred to, as PX-229.

Mr. Owen: And the second one as PX-230.

(The figures above referred to were then marked PX-229 and PX-230.)

Q. I am going to remove these from the preliminary report. Now, Doctor, this set-up that is shown in the second of these figures, which is PX-230, was that used in any of these first five runs? A. That was used in all subsequent runs that we made.

Q. That is, in all those that you made from the stoneware crock? A. Yes. Should I go on with the description of this?

Q. Of that run A. I want you to tell all about that run A, which is not included in your final report—that is true, is it not? A. Yes.

Q. I want you to tell all the reasons why you did not include it in your final report? A. The analysis of the samples of acid entering the tubing system and leaving the tubing system, were turned over to one of my assistants—I believe it was Mr. Riehl—was it not?

Mr. Lightfoot: Yes. A. And without any great specific instructions as to how to make these determinations. And we had in the same laboratory, right opposite his office, a graduate student who was using the orthophenanthroline or colorimetric method for determining acid in low concentrations. And this man Riehl took these samples and ran them by the orthophenanthroline method. I think some of the samples in one or two of the other runs were run by that method. But when we finally adopted our standard method of volumetric procedure, we did not go back and run any of the runs of run A, because we thought that it was not worth while, and I will explain further along that line.

Another factor that entered into the thing was the iron content of the effluent acid showed a great falling off during the run which wasn't particularly noticed to any great degree in the subsequent runs with raw acid. And I would like to give you those figures. Do you have that run A Mr. Lightfoot, to show the falling off in iron content?

(Mr. Lightfoot produced document.)

The iron content ran from 1.055 milligrams of iron per c.c. It went up to 1.15 after the first sample was taken, then started on down to 1.075 but the last composite sample taken was .525—more than a 50% falling off in the iron content. Now in later blank runs that we made, that is, using the raw acid through the tubing, we had changes, as we mentioned heretofore, but they were not of that order of 50%. They were a slight change. For example, the first composite sample in run 1A blank 1350 parts per million of iron, the second composite 1450, and the third 1405. That is a variation of about 25% maximum variation in the composite samples analyzed, and we had over 50% in that one which indicated that something had happened. I don't know what.

Q. With that colorimetric method of analysis, what did you find out about it in connection with these tests? A. I knew all along it was to be adopted only for small amounts. The man who did the work, evidently the student was using orthophenanthroline and he picked it up and used it. It is supposed to be used for minute concentrations of iron.

Q. It was not appropriate for this use? A. Not appropriate for this particular run. Now, we did run later on the gravimetric determination and one or two samples from 1A and they checked within about 10% of the figures that had been obtained from the phenanthroline method, but evidently the method isn't too accurate for great amounts of iron. These were very high concentrations.

Q. And then you adopted what? A. And then I talked to the man and took him off this colorimetric method and put him on the gravimetric method. That worked all right until we got to the high lead concentrations, but it worked very well for blank runs.

Q. And then when you discovered that the gravimetric method was not suitable for analysis of acids containing lead and iron, you dropped that and went to the volumetric method for all? A. We ran back all the valid

samples. We got all the samples from the valid runs and repeated the analysis on all of them by the accurate method.

Mr. Lyon: Just one moment. I was looking for that original book that we had yesterday, that had all of this data in it. A. Mr. Lightfoot, do you have that?

Mr. Lightfoot: Yes. A. Open it up to the page where the data is.

Mr. Owen: When you purchased these thirty sections of oil well tubing did you mark them in any way so as to identify them? A. We marked at least 28 lengths of tubing with a definite number that was kept on that tubing from then on.

Q. What were those numbers? A. From 1 to 28.

The Court: You described two or three methods? A. We described three methods.

Mr. Owen: Which ones of those sections were used in this set of tubing in which you ran your first run, A? A. In run A we used tubes 1 to 5.

Q. Were they ever used again? A. No.

Q. What became of them? A. Well, we started out on the premise that we were going to use one set of tubes for each run, because we thought they were all uniform, and after we had run five tests and consumed all of our tubes we found that they weren't uniform, and came definitely to the conclusion that we couldn't run different tests on different sets of tubing, we had to run different tests on a similar set of tubing, and any comparisons—

Q. (Interposing): You had to run comparative tests on the same set of tubing? A. After giving them a standardized cleaning procedure, which eliminated and presented a new surface inside.

Q. Were any of these first five sections of tubing used in your smaller tests, your laboratory tests? A. As I recall it, several of those lengths were cut up into the corrosion test specimens that we used for later work.

Q. Now, I call your attention to Figure 2 in PX-184, which was identified as PX-174-A, and will ask you to compare that with the last exhibit, PX-230, and point out any

differences between the PX-230 and PX-174-A, both of which show your set-up using the stoneware crock. A. I would like that other figure.

The Court: Here. Is this it? A. These figures are identical as regard the set-up. Starting at "Y" is the steel tubing elbow that we made up with the long side arms on it, welded together, and starting at "Y"—

The Court: You are comparing PX-174-A with PX-230, and not with 229? A. That is correct. This long elbow,—it really was a "T," because at one side, extending down here, we had a rubber stopper in there, and that section form was used in all of these crock runs. Down below here, the end of the straight lengths of tubing, there was a rubber stopper inserted, and I have described that, that had this 1-inch Pyrex tube.

Q. That is in 230? A. Yes, which led out of the end of the tube, past the screw clamp, and into this metering bottle, and we could adjust the flow by means of that screw clamp, and the height of the acid in the bottle indicated the rate.

The Court: What was the object of putting these joints in and not having it to go straight down as it was in the well? A. This set-up has a height of 12 or 13 feet from the top to the bottom, and a total length of one hundred twenty some feet, and we had to take the laboratory, we had to work it around through a door from one lab over to another, and it had to go around a corner.

Mr. Lyon: You could look at this drawing, and the beginning of this was at the top and the other at the bottom and it flowed vertically, but as a matter of fact there was a little incline? A. Slight incline. It was about six feet in a hundred.

The Court: It is all more horizontal than it is perpendicular, I remember that. A. Yes, but these PX-174-A and PX-230 show identically the same system of tubing arrangement and set up used in the run E, which was our fifth run, and the later runs with the raw acid directly from the crock through the tubing system.

Q. Well, using any acids? A. Yes.

Q. Either raw acids or synthetic acids? A. Or synthetic acid from the crock through the tubing system.

The Court: Now, why do you tell me that the apparatus as it was in 229 was any different in result, why would it be any different? A. It would differ but slightly in that this was a short length, it was shorter in length than that, and it was bent around at that angle. We did not have a "T," but this peculiar bend.

The Court: What difference would it make? A. It would make a slightly lower amount of iron dissolved because it is shorter tubing length, and the other difference—

The Court (interposing): But the bend, would that make any difference? A. It wouldn't make a great deal of difference, only that there is a little difference in construction. This tube, which was glass, at the start of the run was open, and that is where the slugs of gas would come up, the hydrogen and slugs of acid would squirt up in the air. So shortly after the run was started and they had acid spilled all around, they connected a rubber tube to the glass tube to get it back into the tank, to prevent it slopping.

The Court: The real reason as to whether or not the bends would make a difference or not, you do say it would make—might make a slight difference— A. (Interposing): Slight difference; not a major difference.

The Court: I would say so far as there are any bends in it, it is different than a well construction. You see the thought I had in mind, Doctor. A. It wouldn't make any great difference.

The Court: All right. I think right there I will ask you, the slight difference, which way would the difference be, the bend, that it would make more corrosion or less corrosion. A. This is an opinion. It would be my opinion that corrosion is increased with greater turbulence, and a right angle bend produces more turbulence than a gradual bend, so you would get slightly greater corrosion with that right angle bend than you would with a bend that came across at 45 degrees, but it wouldn't be a major factor.

In other words, if you pass water around a corner in a pipe or elbow, that water tries to go straight ahead, and it churns up on itself, and if you had acid in the steel pipe that churned up, or turbulence at the bend, it would tend to attack the steel and wipe off that coating.

The Court: It would at one place. I am thinking of the creek and the effort it makes to go straight ahead as it makes a curve, wherever there is a bend it has a tendency to go straight ahead. A. Go ahead.

The Court: Straighten it. We find a greater corrosion at one place, and we find sediment and lack of corrosion at another place. A. This doesn't form sediment, because it forms soluble iron chloride that stays in solution. I don't think it is a major factor.

Mr. Owen: What was the rate of flow through the pipe in these tests? A. The rate of flow, that is the first time we used this rate of flow control, and it varied considerably during the run. We had never adjusted the rate of flow controller before, so it was—there was considerable variation in the rate of flow during the test.

Q. During all the other tests that are in your final reports, the rate of flow was what? A. That was adjusted at one gallon per minute, and we attempted to adjust this first one to one gallon per minute, but the operators were not as skilled as they became later on.

The Court: By the first one, you mean Run A? A. Run A, which was not reported.

The Court: And that is one run? A. Yes.

The Court: Well, when we come to the final results, you ran more than one, didn't you? A. Oh, we ran eighteen total runs.

The Court: But with each pipe—five each, I thought. A. Five or six with the same tubing, with the same number tubing.

The Court: But with this first tubing you only ran one? A. Ran one.

The Court: Discarded that? A. Discarded the tubing. Because we figured we were going to do that in the beginning.

Q. Now, the next one, which you originally marked B, followed the one that you have just described, is that right? A. That is correct.

The Court: In other words, the one he has just described was used with— A. (Interrupting): Raw acid from the crock.

The Court: I wanted to get that number.

Mr. Owen: No. 229, run A was used on that. A. Oh, yes, run A.

The Court: And B was PX-231. Is that right? A. Yes.

Mr. Owen: In the subsequent runs he used PX-230.

The Court: PX-229 was the one that did not have the right angle corner—is that correct? A. That is correct, yes.

The Court: And the one with the right angle corner is PX-230? A. Yes.

Mr. Owen: Will you explain that second run? A. The second run, or run B, was a test in which we took our polarized Menaul tank and connected it to the tubing system, and then at a higher level with it, this stoneware crock, and in the stoneware crock we diluted commercial acid about 15 per cent concentration; and then we tried to run that into the tank, the Menaul tank, and immediately run it through the tubing, with the idea that—

The Court (interrupting): Oh, I remember that one, and you got an average rate of an hour and a half. A. In that tank, and we picked up quite a bit of lead, and we got some inhibition.

The Court: You figured that was about an hour and a half, but it was not definite? A. Yes.

The Court: But it was not definite? A. No, it was not definite.

The Court: It wasn't three hours, and it wasn't any hours? A. No.

The Court: You tried to get a test without staying in there at all—. A. So that there would be no lead or copper picked up from that tank.

The Court: You figure what you actually did was to get an average of about an hour and a half in that tank? A. About an hour and a half in that tank, and we got about one and a half parts per million of copper, and about half as much lead as copper, and we got about half as much inhibition; but the thing we did wrong in this particular test, due to our ignorance, we thought the tank would not corrode very much, but we took only two samples out of that Menaul tank—we filled it up with acid and immediately started running out of the Menaul tank into the tubing, and we took a sample at the beginning, and one about half-way through, just two samples, to try to give us a figure as to the iron content. We thought it would stay fairly low, and when we got through, we found even with two samples, instead of being saved separately, they were blended together to make a composite, and that composite showed 457 parts of iron, or some value like that, about a third as much as was found in the Menaul tank acid later on, indicating—is that correct?

Mr. Lightfoot: Yes.

A. The commercial acid when diluted has only contained five or ten parts per million of iron, and, therefore, after the acid got into the tank, the first sample was probably close to five or ten. The other sample taken half way through the run, when it was blended in equal proportions with the first sample, showed four hundred and some parts per million of iron, indicating that it was a tremendously high concentration of iron.

Now, we did not want to use any figures of iron content where it was changing rapidly, based upon a composite of two samples. We did not think that was an accurate way of doing things. And also the test indicated that it was impossible for us to do the thing we started out to do which was to separate the electrical effect of Menaul from the chemical inhibition effect. In other words, we ran a Menaul test with the wires connected (that is the next test) duplicating Menaul process, and we figured we would get electrolytic protection by the Menaul method, if any, plus the

chemical inhibition effect. Then if we run this acid through so rapidly we would just get the electrical effect and we could measure the proportion of each.

Mr. Owen: That is, you wanted to get the effect of the acid as it existed in the Menaul tank after 6½ hours being stirred periodically, and didn't want it to take up any more lead, copper or iron before it ran through the pipe? A. No, we wanted to run a Menaul test putting the acid in the Menaul tank and agitating it for six hours to get metals picked into it, and then run it through our tubing system. Now, we felt that in that test the protection of the tubing from the acid would be caused by two separate effects. First, any metallic inhibitors; second, the electrical effect claimed in the Menaul patent. So that is a combination of the two effects. And then this separate test, which was run as test B, was to try to separate the electrical effect completely from the chemical inhibition effect. It did not succeed because we got inhibitors in that acid during that rapid pass through. The rate of attack of the acid upon that Menaul tank was so great we didn't take enough samples in order to accurately indicate how much iron was in the acid when it entered the tubing, so we could figure the difference across the whole run.

The Court: Wasn't there any way to let your commercial acid run into your pipe without going through your Menaul tank? A. Yes, and we did that in later tests. But we wanted to give them the benefit of the doubt of having actually a lead electrode connected in there. To give them the benefit of the doubt to get a lead electrode connected in there, and we couldn't run it by the lead electrode in the steel tank fast enough so it would not pick up lead and copper from the tank.

The Court: Have you yet devised a way so you can separate and say how much is due to the inhibition in the acid no matter how they cla a it, the inhibitors in the acid? Is it the sort of a problem you can't unscramble? A. No, we did solve that. In other words here we measured a combination of two effects. To do a real complete job you

would measure each job separately and see if they measured up to the total sum of the two.

The Court: How are you going to measure them separately? A. I will come to that. This attempt we made here was to get the electrical effect separate, and it didn't work.

The Court: I see. A. Now, to measure the chemical separately, we prepared the acid in the stoneware crock with added chemicals and ran it through the tubing and duplicated the composition.

The Court: Did you let it keep on working while you were using it? A. This is a later test.

Mr. Owen: This was in the stoneware crock. A. In the second test we tried to get the electrical effect and could not get it, but the fifth test we ran was a test in which we measured the chemical part alone and the chemical part was equal to the total of the two, see.

The Court: You measured the chemical part in what way? How did you get that? A. By simply preparing this acid with the same concentration of added metals as the acid had in the Menaul process, leaving the Menaul process, going to the tubing and we didn't put the electrode in. When the chemical inhibition leaving from the stoneware crock, going directly to the tube, and the inhibitor gave us the same result as the total of the two, we figured the electrical effect was zero. If it hadn't been zero we would have been quite puzzled as to how to proceed.

Q. And in that run you have just described, and which was identified as run B, you used the equipment as shown in Figure 5 on page 17 of PX-185? A. Yes, that is correct.

Mr. Owen: I think Your Honor saw that. The stoneware crock is above. The acid was put in the stoneware crock and then run down from that crock into the Menaul tank.

The Court: Is that different from PX-230? A. That was the Menaul tank.

The Court: Oh, yes.

Mr. Owen: And 230 doesn't have a Menaul tank.

The Court: That is right.

Mr. Owen: Now, your run B is one of the runs that was not incorporated in your final reports? A. That is correct.

Q. Now, proceed and explain your third run, which was identified as run C. A. Run C is reported in the report as 1-N.

Q. That is in PX-185? A. As run 1-N, and we used in that run tubing numbers 12 to 17.

Q. Oh, I did not ask you, Doctor, what sections of tubing you used in that run B? A. In the run B we used tubing numbers 6 to 11.

Q. Were they used again? A. They were not used again.

Q. Your third run, C? A. Was 12 to 17, and those were run—and those were designated as Series 1 tubing in this test.

Q. And so referred to throughout your report? A. Yes. In this test, this test was a Menaul test, and to just give you the brief elements of it, it is reported in the report. The acid was prepared in the stoneware crock, diluted to fifteen per cent, checked for analysis and inhibition, and then run into the Menaul tank and agitated for about six hours with this periodic agitation, to duplicate or give some manner of equivalent action to the rattling of the truck over the roads, the shaking that it would get.

The Court: When you say that acid was checked, you mean you checked it chemically? A. And by running the inhibition on the third laboratory specimen, or, rather, the little laboratory specimen. We ran both the chemical analyses, and it showed a very low copper and lead content and the inhibition ran from zero to 6½ per cent, of all the acids used.

The Court: What are you comparing that to? A. That is just a small laboratory test.

The Court: Well, I know, but six per cent of what? A. Six per cent reduction. I would like to go into that very thoroughly just a little later.

The Court: But one reason we haven't any standard way, we not only haven't any standard here to go back to the old thing about the conditions, but we haven't any standard as to where we start, either, have we? A. We have a standard—

The Court (interposing): You can fix one, I mean, but another fellow will take another standard. When we take one hundred per cent, nobody knows what that means until they tell. There isn't any standard here, as a starting point, as to percentage of inhibition and percentage— A. (interposing): The starting point is the rate of attack of C. P. hydrochloric acid.

The Court: You have got to go on and tell me under what conditions. A. I know that.

The Court: So there isn't any one hundred per cent.

Mr. Owen: We had to make our own standard.

The Court: Sure. I didn't want to emphasize the corrosion thought I had.

A. In this test, and that has been completely reported and discussed in detail—

Q. Yes. I don't want you to go into that again, Doctor.

The Court: When you found one hundred per cent or six per cent, was that the figure you used, six per cent? A. All of the acid we used, our commercial acid, diluted to fifteen per cent, shows values of zero to 6½ per cent, if I may use the term, inhibition.

The Court: What I want to get at, what did you take as the six per cent of what? A. We took a single piece of steel and tubing and put it in a certain volume of acid.

The Court: Pure hydrochloric acid. A. Fifteen per cent C. P. acid.

The Court: And under the same conditions you put the commercial in. A. That is right, and the rate of attack was within six per cent of the C. P. acid.

The Court: All conditions were exactly alike. A. That is correct.

The Court: Except that one of them was HCl. A. C. P. pure.

The Court: Pure, and the other was whatever you had. A. Commercial acid in that tank.

The Court: All right. Now, I have got it. A. Now, the next run, run D was run—I might mention in this run C—

Mr. Owen (interposing): Your run C that you have just referred to is run 1-M in Table 9 of PX-185? A. That is correct.

Q. Now, will you describe your next run, run D? A. Well, run C, as I mentioned—this is going back to C—is the Menaul tank in which we connected a wire between the tank and the tubing as taught in the Menaul patent. Run D is numbered 2-N and is reported in the report and used.

Q. In report PX-185? A. 185. We used tubings numbered 18 to 23 in that particular run. The number of the tubes were 18, 19, 20, 21, 22 and 23.

Q. And that became your Series 2 tubing? A. That became Series 2 tubing. In that test 2-N we did not connect the wire in the Menaul process. We did not connect the wire. That was the only difference between run 1-M and 2-N. The "M" means Menaul, and the "N" means "No wire."

The Court: That is, no wires connected? A. So we had four runs that we completed at that time, and we went back to run B, that is the quick Menaul test, to see if we could not do it the second time. We hadn't got complete enough data to calculate it the first time.

The Court: Is that run B? A. Run B, so the 2-B was the check on B, and we used tubes No. 24 to 28, on that particular run.

Q. Were those tubes used on any other run? A. They were not used on any other runs.

Q. Well, now, explain very briefly this run 2-B. A. On run 2-B we had all of the iron data, and the inlet acid—

The Court: Could we call that "D"? A. That was not even reported.

Mr. Owen: It is 2-B.

The Court: It wasn't reported? A. It wasn't reported. It isn't in here (indicating).

The Court: I have got A and B, and they are not reported in here, so that doesn't seem to be a reason for eliminating this. A. A and B were not reported at any time. In test 2-B we got the data, the correct number of inlet samples at different times to run the iron on and other metals. We also got the exit samples sufficiently enough to calculate the amount of iron that was picked up in going from the end of the tubing in the Menaul tank over to the exit; but the samples showed a considerable amount of lead and copper, just as we had obtained before, and the amount of iron that dissolved was somewhat less than the amount that was dissolved in run A, in which we had just put the raw acid through.

In other words, we got about the effect that we expected after run B, that if these metals were in there, in checking run B and running it into the tank and taking it out as fast as we could, that metals were picked up which gave it some inhibition in going through the tubing, but it did not determine the thing we were after.

The thing that we were after was to get a clear cut separation of the metallic inhibition from the electrical inhibition. It did not give us the electrical effect alone, and therefore we discarded both of those runs.

Mr. Owen: Now, you have made five runs, and you have discarded A, B and 2-B; is that right? A. That is correct.

Q. Now, will you go o and describe run E, please? A. Now, Run E, at about that time we came to a definite conclusion that we had to, if possible, use, select certain tubes and run the whole series of runs through those same tubes, giving them a standard cleaning out in between each run. That apparently we could not check between runs made on one tubing system under one condition and runs on another.

We had losses of weight, for example, in all of these

runs, we had losses of weight in each piece and each fitting in each of these runs, and they would show variations of 20 per cent, and, therefore, we wanted to use the same tubing and run a whole series of comparative runs through the same tubing system, and so after the first five tests we looked over the data and we picked out two sets of tubing so we would get a check on a series run on one set of tubing and a series run on a completely different set of tubing.

We picked out two sets of tubing that had been run in two of the valid runs that we had made. Now, there were only two good runs out of the first five, because in run A we had this trouble of the varying of many conditions, and the blank, we didn't think that was very good, and, as I recall, at the time when we completed the five tests some of those lengths of tubing had been cut up to make corrosion samples, and so we couldn't run that one or didn't think it desirable.

Run B gave us this indeterminate result that would not clearly separate the electrical effect from the chemical inhibition. 2-B was the same. But runs C and D we felt were valid runs. So we picked the tubes out in those two runs, and decided that we would run, in different order, this sequence of tests that we had outlined.

We eliminated this quick Menaul method, however, in subsequent work. We decided we couldn't do that, because we had tried it twice and failed, and, therefore, we started to run a series of runs using the No. 1 Series tubing.

The Court: 12 to 17.

A. 12 to 17 is the Series 1 tubing. And that had been used in the Menaul test which we had used the standard—

The Court (interposing): You had to renumber it in order to make it Series 1. A. That is right, change the letter designation.

The Court: Yes. But— I see, all right. A. Yes. And then 2-N which was reported, which was a no-wire Menaul test, we figured was a valid test, and the tubing used in that was 18 to 23, and we just called it Series 2 tubing, and that is the reason—

The Court (interposing): 18 to 23, inclusive. A. 18 to 23 is correct. So we did not try any of these quick Menauls any more. We started in our series of running the tests as outlined, dropping out the quick Menaul test.

Q. Explain now your next run, which is Run E. A. Run E was a blank or a raw acid run from the crock, using No. 1 series of tubing.

Q. And that is Run 1-AA in PX-184, is it not? A. That is correct.

Q. That is your Table II? A. That is correct.

The Court: What do you call that? A. 1AA.

Mr. Owen: Now, you explained at the outset, Doctor, that you planned to run five different runs and you have now explained six runs. A, B, C, D, E and 2B. Now, I will ask you regarding your Run 2B, the other 5 runs corresponded with your original plan.

The Court: Let's see about that. Before you start to talk about A. He has 5 runs, discarded 3 of them and saved 2.

Mr. Owen: That is right.

The Court: All right. Now he is starting in to run a series of 6 runs with 2 he has saved out of the 5.

Mr. Owen: And what I want to bring out now is that Run E corresponds with the first of his original plan. A. Yes, sir.

Q. Which was discarded? A. Which was raw acid. We didn't feel it was a satisfactory one and we didn't have Tube 5 to keep a sequence with. We had the four of the originals but we did not have the fifth section.

Q. Then we are down to the point where you adopted these two series, 1 and 2, for all runs? A. Yes.

The Court: And you are going to use the one you used in C for Series 1, and the one you used in D for Series 2?

Mr. Owen: That is right.

Mr. Owen: Well, we have gotten down to your run E as originally marked, and which became run 1-AA in your report, Exhibit PX-184. Now, take up very briefly run F and state what that was and what it became in your re-

ports. A. May I at this time put in the explanation of that preliminary report?

Q. Yes. A. At the completion of run E a preliminary report was written to be sent to Midland to give an idea as to how this work was coming, and Mr. Lyon has read from some of the conclusions of that progress report, conclusions that were diametrically opposed to what I contended at the completion of the work, and the first thing I would like to do would be to read all of the conclusions, instead of just the one, and then to explain just the picture as it existed at that time. I have here this progress report dated March 1, 1940, and at this time we had completed, and as reported here, all of the runs through E.

The Court: What is the date of this report? A. March 1, 1940, and the heading of the—

The Court: Just wait. As I understand it, this is your report made at the conclusion of the five runs up to E? A. That is correct. There were six runs.

The Court: And you want that called preliminary report, March 1, 1940, at conclusion of experiment E? A. That is correct. And the report is titled "Progress report on Menaul tank," and the heading at the end is headed "General comments."

The Court: All right. A. First, the rate of attack of hydrochloric acid—

The Court: Are you going to read the entire report you say? A. No, just the comments. Mr. Lyon read one of the comments, and I would like to read them all.

The Court: All right. A. (Reading): "The rate of attack of hydrochloric acid on various lengths of tubing seems to vary considerable from length to length and be quite dependent upon the method of cleaning the metal surface.

"2nd, in duplicating the Menaul procedure the amount of inhibition exhibited was much greater than would be indicated by the chemical inhibition shown by the entering acid."

Now, that is the statement that he wanted me to explain. In duplicating the Menaul—

The Court: Read that again. A. "In duplicating the Menaul procedure the amount of inhibition exhibited was much greater than would be indicated by the chemical inhibition shown by the entering acid."

The Court: Which leads to the conclusion, just standing right there, that what had been done in the tank increased inhibition, is that right? A. That is correct. That is what one would get if they read that statement alone. I will go ahead with these comments and come back to "Two."

"Third, when the wire was disconnected in the Menaul method even greater inhibition was obtained," which is a conclusion that we have recorded.

The Court: Read that again. A. "When the wire was disconnected even greater inhibition was obtained."

The Court: Yes. A. "Fourth, potential and current measurements cannot be reasonably interpreted.

"Fifth, loss of weight of iron from tubes determined by direct weighing, which was the loss in weight of iron in Menaul tank, may be completely explained on the basis of chemical inhibition."

I am somewhat at a loss as to that particular comment. We have felt that the analytical determination of iron in solution to be a more accurate method than is implied in the loss in weight method from the tubes, and we use the analytical procedure.

"Sixth, we are completing a run in which acid, duplicating in chemical composition that obtained in the Menaul storage tank in run C will be run directly from the stoneware crock to the tubing, the same tubing used in run C, 2-B and E will be used."

That is the sequence of the tubing.

The Court: Well, that sounds like you are telling what is going to be done in what you had in E, rather than— A. (Interrupting): No, in E we ran simply the raw acid for one set of tubing. We are telling him what we are

going to do in the synthetic run. At the time of writing this report we had no synthetic run. All we had to go on was the comparison of the reduction in corrosion in this Menaul tank.

The Court: That you rigged up? A. Yes, and the raw acid, and we found that there was 75 per cent reduction in corrosion, whether we had the wire connected, or not, over what we got with the raw acid; but on the acid that we fed into the system, the acid that went into this pipe in the Menaul tank,—we had taken samples of that and tested it in the laboratory for the amount of inhibition, simply by putting it in this beaker with a small volume of acid, and allowing it to stand, and comparing how much it had reduced the attack of the acid, that is, the metals that we put into the Menaul tank, so we were comparing the reduction in attack in a large system with the reduction in attack in this small specimen test. And the small specimen test that we used at that time was this, we took a small section—I cannot give you the exact dimensions, but I could look them up, but in general it was about an inch by three-quarters, cut out from the side of a piece of oil well tubing, and about three-tenths to four-tenths of its area was this cut-out edge of the section of the sample.

The sample was cleaned and then immersed in a small volume of acid, and allowed to stand for thirty hours; and when we got through with that test we found that the acid that had been taken from this Menaul tank just before, and during the run, when it was running into the tubing, the acid with the lead and copper and iron it had picked up in the Menaul tank, that acid in this laboratory test had shown between 30 and 40 per cent reduction in corrosiveness only; and, therefore, when comparing in this report with the only data we had,—we had not completed a single large scale synthetic run, we were comparing results on our laboratory inhibition tests with the results of this large scale test, and we have gotten 75 per cent, or plus or minus 10, reduction in the large scale equipment, we have shown that the wire made no appreciable difference in the results,

which also would tend to indicate that there was no—quite definitely that there was no electrical protection, and we got 30 to 40 per cent inhibition on the acid in this laboratory test, and 75 per cent on the large scale test, and, therefore, the only comparison that we could have made now was the comparison of those two figures, and, by the way, it seemed—it simply appeared as though maybe there was something there from that particular comparison.

Now, following this particular progress report, and as indicated in here that we were going to run this synthetic run, which would really answer the thing, because we would have two large scale tests to compare following that run—the run E, we then went to run F, or run 1-B, which was the first synthetic run that we had made, and the date on which we had that run was March 17, 1940. This report was dated March 1, 1940. The first synthetic run that we made was run 1-B.

Q. And that run, as I understand it, was run from the crock? A. Directly into the tubing.

Q. In which you placed 15 per cent commercial hydrochloric acid, and added to it the metals corresponding in amounts to those found in your Menaul run? A. To those found in the Menaul run, 1-M. And we found that with the synthetic acid we got 238 grams of iron dissolved from the tubing, and with the Menaul run 322 grams of iron dissolved. The synthetic from these figures would appear somewhat better but it was at least as good.

Q. Then, Doctor, you go on through your subsequent runs down to Run I and explain them quickly. A. The next run was Run 1A or G in our data book—G or 1A. Now, the purpose of running that particular run and in the order that we had run it was this: We had in Run E run raw acid through the tubing. After that raw acid run we had given the tubing a thorough cleaning out with our standard cleaning procedure and we ran run 1B, the synthetic run. Then we came back and ran a raw acid again to see if the cleaning out procedure we used would take any metallic coating off the inside of the tube and

give us a fresh surface that would be comparable with the fresh surface of the pipe prepared before acid containing the inhibitor had been run through.

Q. This is 1A? A. 1A is our report and G is the letter in the book.

Q. Raw acid again? A. Yes, sir. We found in the first we got 943 grams, the second 1043. We considered that was probably the limits of accuracy of the metal but at least we had gotten a fairly close check on the attack of commercial inhibited acid or diluted acid to 15% strength upon the tubing.

Then Run H, which is run 2M which is reported, was run on Series 2 tubing. Now, we had only previously run 2N or D on that set of tubing so that we had a Menaul method following the Menaul without the wire. The first test made on the series 2 tubing was the Menaul minus the wire. Then we ran a Menaul with the wire in the same tubing after, of course, cleaning it out as described. Then—

The Court: What about the wire? A. The wire was connected. That was the Menaul procedure. And then Run I was to have been a synthetic run and it was run upon series 2 tubing, and it was supposed to have contained after we had added the chemicals to it, the same concentrations of lead, copper and iron that were present in the run 2M.

Q. That is the last one you referred to? A. Yes. Now, that is the one run after we started on this 2 series of tubing system that has been dropped out of the report, and I want to explain that.

The Court: This is I and what is the other letter? A. There is no other letter because it wasn't used in the report. In Run I we calculated the amount of copper salt to be added and the addition was supposed to have brought the total concentration up to about 2.8 parts per million of copper. The number that is written in our data book of added copper salt would correspond to about 2½ parts per million and there was around .3 of a part per million in the original acid, which would theoretically make everything correct.

Now, we ran tests after the acid was blended, the chemicals added. We ran this small scale inhibition test upon a sample of that acid before it went into the tubing. The percentage inhibition shown in that test instead of being around 30 to 40, which was usually the case with synthetic Menaul type acids, as I recall it ran 16 or very close to 16, indicating about half or maybe a little over half of the inhibition that one would expect in an acid that contained 2.8 parts per million of copper. The analysis showed around 4 parts per million, and that is the analysis that I doubt seriously of the inlet acid, 4 parts per million, much more than we had actually added. The analysis of the exit samples—and we have three of those determinations in duplicate—all showed from 1.2 to 1.4 parts per million. The loss in weight of the tubing that we obtained was 469 grams of iron. From the tests that we had made and have made since then, that loss in iron would agree very closely to the loss that you would get with about 1.3 or 1.4 parts per million of copper. It would not agree with the 4.

The Court: This is the experiment that you and I finally reached the conclusion there were six elements to be considered and two of them must be wrong, and you thought the one most likely wrong was the one that—

(Witness, interposing): —had the least possibility. That is correct. That is the one test that we have dropped after we adopted this 2 series tubing. That is the only one. Now the other tests, in order, and without any great amount of discussion as we have gone over these, run J, or 2B was synthetic; then run K, which was a blank, 2A in our report, followed by L or 1N, which was a no wire test on the first set of tubing—that is the Menaul test without the wire, then followed by N, which was a synthetic on series 2 tubing and is listed as 2D in our report.

Q. Doctor, after you discarded run I, how soon did you run a duplicate of that test? A. We ran it as soon as possible.

Q. Which one was the duplicate? A. It was run J.

Q. The next run. A. Or 2-B was immediately fol-

lowing that, indicating that at that time that we thought there was something wrong, or else we would not have run a duplicate on that.

The Court: How many did you save all told out of all these tests? A. Out of the ones that we have reported without oil,—there are two oil tests,—those have been discarded, and they were not really run under controlled conditions, exactly controlled, because they were preliminary studies.

The Court: Out of the others? A. Out of the others there are 17 tests.

The Court: 16 tests, and 4 of them discarded. A. 4 of them discarded. Two of those discarded were those quick Menaul tests. One was the first test which we didn't have correct cleaning procedure, or other exact analysis procedure, and there were a number of factors wrong there, and then the one, which I will admit is argumentative and debatable is run I.

The Court: It turns out there is just one-fourth of the tests that were discarded? A. That is correct.

The Court: And two oil tests, we aren't counting, that were discarded? A. That is right.

Mr. Owen: Now, Doctor, referring to the copy of your letter of January 28, 1941, to Mr. Rebbeck, in which you made some curves showing the rate of corrosion of the uninhibited 15 per cent acid and of the Menaul acid, that is, from the Menaul tank, can you, or have you the figures from which these crude curves were made? A. Well, following the writing of that letter we ran additional tests, and the data is in this book and could be presented in graphical form, and I don't think I could pick it out of here and calculate it. It would take some little time, and I think it would show up much better in graphical form.

Q. I would like to have you do that, and how long would it take? A. Well, it might take an hour or longer.

Q. I would like to have that done and when done I will offer it in evidence? A. You don't want me to do it right now?

Q. No, wait until you get off the witness stand, and if you possibly can do it so that we can get it in today, so that if counsel wants to cross examine on the basis of it in your notebook you will be here to explain it. Now, you testified that you made tests in accordance with Figure 1 of the Menaul patent and that your results were in general, or generally corresponded with those produced by Mr. Gardner in his affidavit? A. Before we go on to that should I explain those two laboratory tests that we have used for measuring this rate of attack?

Q. Yes. A. I mean that fit in with the picture of these large scale tests, and it is one of those things that I think should be thoroughly understood, and we have mentioned that we used two tests. I mentioned to you at the time of writing this preliminary report that we had used this sample test and run it for a very long period of time, and then the thing after we had run the synthetic run, then we had the problem that the big scale test showed 75 per cent, and the small scale test showed 30 per cent inhibition or so, and to try to find the factors that entered into that we studied the determination in a laboratory way of getting a laboratory test that would duplicate as close as possible the conditions in this large scale equipment.

Now, one thing that we wanted to show with that was that if we took chemically pure acid and added these chemicals to it, that there wasn't some unknown element, X, or something in there that was doing some sort of maneuvering that gave us that large scale result. And further we studied first the surface condition of the samples.

We decided that if we wanted a test that would compare with our large scale test that we ought to use the same method of calculating the samples, and that we shouldn't disturb a great proportion of area of the surface by cutting it with a hack saw, or some method like that, and so we went to a larger specimen and we used a 1-inch length of this 1¼-inch tubing.

We used a 1-inch length of this 1¼-inch tubing. We faced the ends off in a lathe, and got a smooth finish on

the ends, and we finished the inside in the same manner that we finished the large pipe; and the outside we did as close—cleaned it as close as possible to the method used for cleaning the inside. We put it up against a hard wire burnishing wheel which would take the outside coating off, and make a burnished outer surface on the sample.

We pickled the sample before that operation, and washed it with solvent, and then gave it that operation, and then a final washing in solvent as is described in this report.

Then we used the same ratio of acid volume to area of the sample as existed in this large scale test, that is, a certain volume of acid, a certain area of attack, the time was kept the same, the temperature. The only thing that we could not quite reproduce was the agitation, we could not do that in a reproducible manner to let the acid through that small section.

Carrying out the test in that manner, we got results which did not quite agree with the figures that we—when the acid was run through the large tubing system, but it came up pretty close to it, and we thought from work that we had done that increased acid flow gave increased inhibition, or reduction of corrosion; and, therefore, it would be logical to expect possibly that there would be some difference in inhibition.

In this report that I mentioned—I do not recall the PX exhibit number—but the report on the corrosiveness of 15 per cent hydrochloric acid, in that we describe that test, and give the reduction in corrosiveness of various metal contents in C. P. 15 per cent HCl, by that test, and those figures are very comparative, and we used various proportions of copper, lead and iron covering the entire range of any compositions that we had obtained either from our Menaul test, or that had been reported to us by Mr. Rebbeck as having been found in the defendant's samples by Dr. Bartell.

And the figures were 60 to 70 per cent inhibition, close to that range. And we varied the copper. I think I have

described this before. We varied the copper from about two, a little over two to about four parts per million, the lead from around 200 to 500, and the iron from about 400 up to 1300 or 1400, and over that range of compositions the inhibiting action or the reduction in rate of attack was found to be around 60 or 70 per cent.

Now, in our large scale, we got from 65 to 80 per cent, approximately, and we felt that this difference could possibly be explained by the velocity. And then we ran this check of length of time of contact on the samples, and we found that the reduction in rate of corrosiveness was almost constant between about ten minutes and about fifteen hours or so, and it started to fall off at the end of that.

Q. That is the curve you are going to prepare? A. That is the curve I am going to prepare. And the confirmatory nature of that test, with the large scale test, which we duplicated as close as we could in the laboratory, that is, in the small scale laboratory test, indicated to us the validity of our large scale test, and so the two agreed, in our opinion. And so, on the basis of that, the conclusions that were reached, I have expressed already, that the acid containing from 2 to 4 parts per million of copper, and from several hundred parts per million to 500 parts per million of lead, and 500 to 400 to 1300 of iron, in the form of chloride, that that acid, under the conditions of these tests, and apparently from a study of the effect of some of the variables under quite a range of variables and time of contact, gave us an appreciable amount of inhibition or reduction in rate of attack of the acid upon steel oil well tubing.

Q. Now, I have a note here, Doctor, that your preliminary report of March 1st, 1940, in which you report on the first five runs, made no reference to your Run No. B which is one of the discarded runs. A. Yes. That B was never even calculated, because we knew we didn't have sufficient data on the entering acid.

Q. Now, in connection with the Gardner affidavit, you testified that you made some tests following the disclosure

of Figure 1 of the Menaul patent, and that you got low potentials similar to those referred to in the Gardner affidavit. A. We ran such tests in the laboratory, inserting a strip of steel and a strip of lead into hydrochloric acid of various concentrations contained in a beaker, similar to the sketch shown in the Menaul patent, and determined with a potentiometer the potential difference between the two strips of metal.

Q. And that compared favorably with Gardner? A. I would consider it a favorable comparison. I think we had quite a discussion about some differences there, but I think they are in substantial agreement.

Q. I want you to state whether the results of your—of those tests which you made in any way alters the views you have expressed regarding the effectiveness of the Menaul method in giving protection to the well tubing? A. It does not alter one particle the conclusion that I gave you or my opinion on that matter.

Q. The fact has been brought out in cross-examination that in your Menaul tests you grounded the lower end of the tubing instead of the upper end of the tubing, which would ordinarily be grounded in an oil well. How would the change in the point of grounding affect the amount of current passing down the tubing? A. Why, I have testified that the grounding of the tubing at any point along the tubing would be substantially identical because the tubing is a very high—has a very high conductivity, and it was brought out in cross-examination, I believe, that this tube was grounded through contact with the casing at the top, and which would indicate a difference between what we have carried out in our test and what occurs in a well. I do not believe that makes any difference.

Then it was brought out that possibly the current we measured was not all the current that passed in that circuit, that some of it may have gone into the ground, and the connecting of the ground to the bottom of the tubing would tend to make it easier for such a current to pass down and protect the tubing, and if there were going to be

any protection, why, it would be protected better along the tube and down to the bottom end by such a connection.

Q. Where did you measure the potential in your tests made in accordance with Menaul's figure 1? A. The potentials were measured directly between the side of the tank and the tubing, the end of the tubing system, which was dipped into the acid.

Q. And where did you measure your potentials in the Menaul tests? A. That is what I just described to you, in the Menaul tests I measured between the tank and the tubing.

Q. Oh, yes. I wish you would compare the potentials you found in your tests, corresponding to Figure 1 of the Menaul patent, and those you found in your tests using the 110 feet of pipe. A. I believe that I went into quite a thorough discussion of the voltages that I measured between the strip of lead and the strip of steel in this little beaker, and they were around one-tenth of a volt, if you recall. Gardner got eight one hundredths, and I got thirteen one hundredths as the top figure, and in between we criss-crossed, but they were substantially a tenth of a volt.

On cross-examination I was asked as to the exact number of these potentials, and I got down a certain way in reading voltages before I was stopped, or interrupted, or something. In run 1-M, the voltage that occurred between the tank and the tubing at the start of the run, when the tank had 40 inches of acid above the lead sheet in it, was 0.00 volts.

The Court: Above the bottom of the lead sheet? A. 40 inches above the top of the lead sheet, which we measured.

The Court: Oh, the top of the lead sheet? A. Yes. It was 0 volts. Then when there was only 34⅛ inches of acid left in the tank, the voltage was .0012 volts. When there were 26½ inches of acid left in the tank, there were .0018 volts. Then when the acid was 22 5/8 inches deep, about half of it had gone through then, there were .0039 volts. Then when the acid was 18 5/8 inches, when there was that much acid left in the tank, it was .0043 volts.

Then when there was 15⅛ inches of acid left in the tank, there were .0081 volts. When there were 11⅛ inches of the acid in the tank, the voltage was .0174. When there were 7 inches of acid in the tank, the value was .030 volts. When there were 3¼ inches left in the tank, the value was .064 volts.

Now, I have four runs, and they all show potentials and voltages of about that same order of magnitude; the voltage was practically zero, and as the acid ran down in the tank, the voltage started up toward the values that we got in the beakers, they started up towards those values. But it did not occur until there was just a layer of acid covering the lead sheet. Now, one of the principles of the Menaul hypothesis in the plating of this tube is that a large flow of current occurs and coats over this tubing to flow into the tubing and give it this polarization, and these figures clearly indicate that nothing like that occurs in the beginning.

Now, the voltage you get at the end is due to the fact that when you take a composite electrode, and an electrode that is four-fifths steel and one-fifth lead, and you measure the potential between that electrode and another electrode, you get sort of average voltage of lead and iron between what other electrodes you are measuring, and therefore since the acid in the tank is in contact largely with steel in the beginning, you get a voltage of steel to steel, which is substantially zero, and then toward the end when the acid has fallen down and is in contact with almost 99.5 per cent of lead surface, then the potential of that element is about the same as a sheet of pure lead measured against iron, which we found to be one-tenth of a volt in our beaker tests, but that still,—the explanation that I have given, or the opinion that I have given on the impossibility of this few hundredths of a volt, even in the last few inches of acid, in the test, of doing any protecting, the possibilities of that are—I do not believe exist, and these voltages, the change in voltages is exactly what you would expect and you cannot on the basis of those potentials give any credence to

the idea that there was a polarization due to a flow of current, and then the current stops and you have everything held free from corrosion.

RECROSS EXAMINATION

By Mr. Lyon:

Q. I have a few questions. Did you make any tests to determine the amount of copper and lead or iron that would be picked up by the acid if you put it in the Menaul tank, or the rate of corrosion in that tank of the acid if the plate was not bonded to the steel wall? A. No, we did not. We did make some preliminary calculations. We found so much corrosion there that we just wondered. We thought, and I still think that the lead sheet does protect the tank somewhat, and we tried to make some rough calculations that would indicate that it might protect it 30 or 40 per cent, but that could hardly be exactly. We have nothing to compare it with.

Q. You referred to that as a little bit or a slight amount the other day. What amount of protection did you have in mind? A. Well, I don't know from electrolytic protection. In these rough calculations we figured 30 or 40% electrolytic and then there is some chemical inhibition. Just what the total might be, it might be fairly high. We found a considerable amount of iron dissolved much more than the field samples showed. We had four times as much iron in our solution at the end of six hours with mild agitation as Rebbeck reported to me as being found in the field samples.

Q. Did you make any tests attempting to find out what the results would be if you could get a lead plate that contained no copper and were able to entirely exclude copper from the system? A. No, we did not.

Q. Would you have any idea as to what the results would be if the defendant's system, the Menaul system was operated just the way it was and by some means you were able to keep the copper out of the solution? A. I couldn't tell you that without running tests, I don't believe.

Q. You didn't run any? A. No, we did not run any tests whatsoever on that.

Q. This brush that you used as a burnishing brush for the tubing between tests, what was it made of? A. It was a hardened steel wire brush. Mr. Lightfoot, could you describe it better? What were the wires? They were round wires, cross section, and about how long? Was there any copper or anything on that brush?

Mr. Lightfoot: It is a brush commonly used for cleaning flues.

Q. That brush would scatch the inside of the tubing more or less, abrade the tubing. A. Somewhat.

Q. Isn't that known to affect the rate of corrosion of a metal if you abrade it or scratch it? A. Yes.

Q. It changes the rate.

The Court: Because you increase the surface. That is the main reason. A. That is one reason. If you work metal it tends to corrode a little more than if you do not.

Q. Have you read this current article appearing in the August, 1941, edition of Industrial and Engineering Chemistry entitled "Causes of Corrosion Currents" written by R. B. Mears and R. H. Brown of the Aluminum Company of America? A. I have been too busy sitting here in the courtroom to read any articles.

Q. You know this publication? A. Yes, sir.

Q. Did you ever hear of either Mr. Mears or Mr. Brown? A. I am very sure I have.

Q. Are they competent men in this field? A. As I recall they are. Mr. Mears, I am quite sure I have seen his name.

Q. There is a summary apparently of this article at the top, as I guess they have in these various scientific articles, in larger bold face type, and I am going to read to you and ask you if it is in accord with your experience—"Localized attack of metal specimens is often the result of electrochemical corrosion, not of simple chemical solution. The appearance of specimens suffering this type of attack has led laymen to attribute it to the presence of impurities

in the corroding metal. However, impurities are only one possible cause for this type of attack. Other known or possible causes are: (1) grain boundaries, (2) orientation of grains, (3) differential grain size, (4) differential thermal treatment, (5) surface roughness, (6) local scratches or abrasions, (7) difference in shape, (8) differential strain, (9) differential pre-exposure to air or oxygen, (10) differential concentration or composition of the corroding solution, (11) differential aeration, (12) differential heating, (13) differential illumination, (14) differential agitation, (15) contact with dissimilar metals, (16) externally applied potentials, and (17) complex cells. In cases encountered in practice, 4, 6, 10 and 11 appear to determine the local sites of attack more frequently than do any of the others.

"The magnitudes of potential differences generated by several of the causes listed have been determined experimentally and are given in the paper. In several cases examples illustrating the special attack resulting from these causes are described." A. What do you want me to say?

Q. That is a list of the different factors that can affect the corrosion? A. Sounds like a very complete list and the degree to which they affect corrosion, of course, varies from case to case. Was your question directed to the mechanical working?

Q. No, I was asking if this was in accord with your experience; these are the factors that affect corrosion. A. Yes.

The Court: He has left out of there the different kind of thing—whether it be air or fluid contact. A. This is all water solutions they are talking about. He mentioned the condition of the solution.

The Court: There are seventeen different kinds of things, then, that you agree affect the percentage of corrosiveness or inhibition of anything?

Mr. Lyon: The rate of corrosion, I would put it. To digress for a minute. If you are not familiar with it, I would like you to look at his data here. You may have already experienced it. He shows a difference in illumina-

tion of the same surfaces; one being lighted and the other not, would make a difference. A. I think it was kind of dark inside of those tubes.

Q. Well, is that your experience? A. I have no experience with that, and the tubes were dark inside, and the bottles that we had in our thermostat for the lab tests were only a small percentage of the surface area—I mean, only a small percentage of the surface area was exposed to the light. I don't believe that that would account for much. I think you asked me a question about the surface working on metal.

Q. I did, and I thought you answered it. A. All I wanted to say on that was that this wire brush did not disturb a great portion of the depth of the surface, and that is shown in this time of contact of the acid on the oil well tubing. The curve I am going to present tomorrow gives at the start—the rate is very fast, and it is taking off that loose metal and the working metal. The work metal will usually dissolve much faster than the annealed metal, and that occurs in the first few minutes. That is where your 17.8 per cent came from, and that is one of the reasons of running it a greater length of time, because that gives you a more reproducible and more representative value on the reduction of corrosion rate.

Q. Of course, there would be no possible way that the man running this boiler job cleaner through those tubes back and forth could be sure that he had the same abrasions, and the same amount of working on the inside of the tube in one operation, as compared with another; he would just have to take a chance on that and do the best he could?

The Court: Maybe you could make some tests and tell whether the brush took out the dandruff, or whether it just scratched the scalp. A. We did. We didn't make tests, but we just measured what came out, and there was a little black material, which was probably impurities and particles on the surface, but that was all that came out, there was no steel.

The Court: The thing I have got a picture of is that brush is a pretty harsh brush, I wouldn't want to brush my hair with it. I just wondered that if you kept on using it there, if you would not keep on getting little particles of iron out. A. You would get some, but it was only brushed through once and pulled back once.

The Court: Every time it goes through then it probably digs a little bit of iron. What is loose will come out easier. A. Yes.

The Court: You take those are almost at right angles, except to the extent you bend them to that wire? A. That is correct.

The Court: I suppose they would tend to abrade? A. And I am perfectly willing to admit that.

The Court: The extent of it I haven't any idea, but I would think it would abrade some. You never did make a test by weighing that iron pipe before and after. A. In the corrosion tests?

The Court: Yes. A. We have those figures and they agree quite closely with the figures in the analysis.

The Court: In that sort of test when did you weigh your pipe? A. After I cleaned it. The figures in general are higher. We took only, took out a few grams with that brushing out operation. It was really the start of another test.

REDIRECT EXAMINATION

By Mr. Owen: Q. I want to ask the doctor if these charts which have been produced correctly represent the data contained in his reports PX-184 and 185? A. They do.

Q. And I will ask you further, did you check the figures on those charts after they were submitted to you by Mr. Rebbeck, after drafts of them were submitted to you by Mr. Rebbeck in connection with his letter of July 11, 1941, Defendant's Exhibit No. 227? A. The figures agree. The results are the same. When we wrote up our

preliminary reports we did not want to use any per cent reduction in corrosiveness. We simply wanted to indicate a rate of metal dissolving, and with raw acid, and report the rate of metal dissolving with the acids that we found in the various tests. And that was one of the main points that was mentioned in some of these talks and letters was that the attorneys had decided, well, we are going to do this way, and then Mr. Rebbeck agreed to re-calculate the results and make up a chart which I could check, based on the method of presenting the results.

The Court: Doctor, what would be a definition of inhibition? A. The word "inhibition"?

The Court: As applied to chemistry. A. Not per cent inhibition?

The Court: No. I am intentionally leaving that out. Or I will say an inhibitor. Perhaps that would be a little easier. What would you say a chemical inhibitor was? A. An inhibitor is a substance which is usually put into a corroding medium in small amount and which reduces the corrosive tendency of the medium.

The Court: Well, now, you have just testified to using something that inhibited, because inhibited is the reverse of corroded, and when you tell me it stops corrosion you have just used— A. (Interposing): That is true. It is a vague term, but that is my conception.

The Court: Well, Webster says that it is something that prevents reaction. A. That is probably more exact than my statement.

The Court: Well, I am wondering now, is Webster right, and that I have led you into a good definition by quoting Webster? As to what prevents it, is it the coating or the plating that goes on? I have trouble when I read "inhibition" to try to apply it to the results I have got. A. There was some discussion as to whether the material had pulled the teeth out, I think the term was used, of the acid.

The Court: Yes. Webster seems to speak of it, he doesn't say that, of course, but you think, to read the definition, that there was a reaction took place in the corrosive

substance, that the reaction took place, that prevented it from corroding by a reaction taking place. Now, that is rather contrary to the plating idea, isn't it? A. Well, there are different types of inhibitors.

The Court: Of course, he doesn't say anything about hydrochloric and he doesn't say anything about arsenic or any of these inhibitors we have talked about, and I take it that it is a term that applies to many things other than hydrochloric acid and steel. A. Yes, very many. Oxidation, lubricating oils.

Mr. Owen: I have here the chemical engineering dictionary, which contains a good definition of inhibitor. (Reading): "Any substance which slows down or prevents chemical reaction or corrosion." Very much like Webster.

The Court: He didn't put the "corrosion" in.

Mr. Owen: Webster did not.

The Court: This is better. Webster just had the broad idea.

Mr. Owen: Just one further point that my associates are a little bit disturbed about, and that is the statement that I was responsible for Dr. Prutton's reports, and they are very anxious to have me read these letters which were offered, but I don't necessarily want to do that, if—

The Court: I will say this on the record, that I think in most courts they would never have found out about that, and I think that what has been done is usually done; they talk together, and they work together. Of course, you have the natural prejudice that anybody has, trying to honestly represent the people he is working for; and it is easier for you to see your side, and the others to see their side, than perhaps it is for me to see either of your sides. I can see that that enters into it. I am not feeling cross towards anybody, or thinking ill of anybody. If that is what you have got in mind, you don't need to spend any time on that.

Mr. Conner: Mr. Lyon had said, he was having you (Mr. Owen) telling Prutton what to report.

The Court: Most judges don't get into all that sort of thing, but I do, and it is helpful to me. I think it is a good thing to do myself.

Mr. Owen: That is all, then, Your Honor.

The Court: You see what I am doing, I am putting my own approval on what I have done.

Mr. Owen: That is all I have, Doctor.

The Court: I am putting my own probe in.

Mr. Owen: I wasn't disturbed about it, but my associates were.

The Court: I say feel perfectly free to put in anything you want, but I am not surprised at what I found out at all, and I am going to be surprised if I don't find that the others have made some experiments that they think they made a mistake in.

Mr. Owen: I hope that their insides will be turned out as thoroughly as ours have been.

The Court: I will try just as hard to do it.

Mr. Owen: Dr. Prutton has made that sketch I requested. I would like to have him explain it. I will give it exhibit number PX-234.

(Whereupon the sketch was marked PX-234.)

Dr. Prutton: Now this chart was prepared from data that was obtained when samples of this 1¼" oil well tubing 1" long were tested for the amount of corrosion in this standard laboratory test that we employed which gave results comparable, as we felt, with the large scale results. We tested the rate of corrosion using different lengths of time of immersion of the specimens in the acid. If we plot vertically over here (witness drawing on blackboard) the rate of corrosion or the grams or iron dissolved per square meter of surface per hour of contact, those numbers are plotted vertically, and horizontally we plot the time of test or time of contact in hours, and we start here with 2 hours, 4, 6, 8, 10, 12, going out to 16 hours; and here (indicating) we plot, let's take a maximum of 125 grams, 100, 75, 50 and 25.

The first tests were made upon 15% chemically pure hydrochloric acid and the time of test was 3 minutes. The rate at which the iron dissolved, figuring from the weight loss from the specimen and area surface exposed, time, the

rate was for 3 minutes which was practically over here and against the axis was 107 grams of iron dissolved per square meter of surface per hour of contact. That is simply the rate at which the iron was dissolving over this 3-minute period (indicating on the blackboard). Then the next test was run, using a section of oil well tubing in 15 per cent C. P. hydrochloric acid, and 6 minutes was employed. Now, at 6 minutes, the average rate of solution of the iron was 82.2. The next test was run for 12 minutes, still over in close here (indicating), and was 77.8. You see, this was 82.2, and this is 77.8, at 12 minutes. The next test, and these are entirely separate tests that were run in duplicate, this is a 30-minute test, which would be a half hour, and this is 76. In other words, the rate of dissolving of the iron by the acid was very rapid here, and then in a few minutes it came down to practically a constant rate. Now, 3 hours, in the 3-hour test the rate was 72½. 6 hours, 71.8. At 9 hours it was 70. I will put the numbers opposite each point. In 16 hours, the rate is—I have it indicated on the graph here, but I do not have it numbered. It is about 60, out here (indicating), plus or minus 2. That is just from the graph, which I took from the data. I don't recall the number. Now, this curve for C. P. hydrochloric acid shows—

The Court: That is almost a tangent, after it reaches 3 hours? A. 12 minutes (indicating). This is 12 minutes. This is 6 minutes here (indicating), and this is 12 minutes here, and then 30 minutes. Now, if we take an acid containing copper, lead and iron in a concentration of—this particular acid happened to be three parts per million of copper, and a thousand parts of lead, just a little higher in lead. Then the defendant's acid, or the acid that we obtained from the Menaul tanks that we employed, for a laboratory test, gives us the same rate substantially at the 3-hour test—in the 3-hour test with this acid containing lead, copper and iron, 3 minutes gave 80 grams per square meter dissolved. Six minutes gave 69.8. And 12 minutes 40.4. And 30 minutes 34.8. And 180 minutes 22.2. And

360 minutes 17.6. Now, 540 minutes, or 9 hours, 18.4, which is a little higher but substantially the same. Now, if you draw a curve through these points as well as you can, with this acid containing copper, lead and iron, you get a curve of that type (indicating). The difference between the height of this line and the height of that line (indicating) is what we have been talking about as this percentage inhibition, if you express it in percentage of the total height, or if you just take the difference here you would have a reduction in the rate of corrosion. For example, if we have an iron tubing in 15 per cent C. P. acid and we run a test for three hours, we get a rate of 72.5 grams of iron dissolved per square meter per hour. If we run it with this lead, iron and copper containing acid, 22.2. Now, these figures are quite representative of and are within one or two units, this of the crock acid that was used in our tests, in all the tests we ran on the crock acid, and this of the Menaul or synthetic acid. In other words, within two or three down here and two or three up here (indicating).

Mr. Owen: That upper line, Doctor, you said all the tests you ran? You mean all? A. These were run with C. P. acid.

Q. Without any additions? A. Without any additions whatsoever. Now, our actual crock acids were a little lower than that. We ran a curve for those, but they were somewhat lower in the three hour test, but here we have this C. P. and the difference between the two is the inhibition. Now, in a letter that I wrote to Mr. Rebbeck I gave him some preliminary numbers for this difference up here, or three minutes test, which showed about 18 or 20 per cent inhibition. At three minutes this height is 20 per cent of the total height, and that, as I explained, I am quite sure is due to the loose iron that is on the surface being attacked at a more rapid rate right at the beginning, to loosen that up. You see, there seems to be lost practically no weight. All this loss of 107 grams per square meter per hour, you only have it on one-twentieth of an hour, and the amount dissolved is that loose fuzz on the surface.

When you get down here to a ...ing over twelve minutes you are getting down to wh...e drop in corrosion due to the addition of these metal... educes the corrosion about fifty per cent, that is, the ...rosiveness or rate of corrosion of acid containing copper, lead and iron is about half of the total height of the corrosiveness of the C. P. acid. When you get over here it is 60 to 70 per cent, but between 12 minutes and out here as far as we went the difference here is not tremendous.

Now, that was the figure that was cited out of this letter that was written and the reasons for the running of this curve was in explanation of what we felt was happening in the rate of corrosion samples.

RECROSS EXAMINATION

By Mr. Lyon: Q. In accordance with what you have just illustrated on the blackboard and with this curve you have produced the per cent of reduction in corrosion as illustrated on the chart such as PX-189 or the one in front of you, which is one of the corresponding charts would be different for each difference in time, isn't that correct? A. At any time between 12 minutes and about 7 or 8 or 9 hours out here, if we measured the difference might be 10 or 15 per cent.

Q. As against what? A. As against,—that is, 50 compared to 65 or something like that,—55 compared to 70.

Q. Now, I want to ask you as follows, and you can take this down if you want to, in taking the figures you have put on the blackboard, the per cent of reduction in corrosion in the system that you have illustrated there for three minutes would be 25.4; 6 minutes, 15.0; 12 minutes, 48.0; 30 minutes, 54.0; 3 hours, 69.4; 6 hours, 75.5, and 9 hours, 73.7. If those are not correct, it will just take you a minute to check them and I wish you would give us the actual differences in per cent, using the method of calculation that were used in these charts, such as PX-189 for the 3 minutes, 6 minutes, 12 minutes, 30 minutes, 3 hours, 6

hours, and 9 hours. A. Well, do you want the exact figures, or a general statement? You don't want any exact figure?

Q. Just substantially. A. Those are substantially right, I would say.

Q. The ones that we gave you? A. Yes.

Q. We calculated them in a hurry. A. They are close. In other words, here is—substantially they are right. I would say, just looking at them, I would say they are substantially correct.

Mr. Owen: There is one other point I want to cover. Your Honor will recall that back in the beginning of this case we introduced as PX-10 a chart with some parallel streams and a delta at the bottom, showing the results of the Grebe-Sanford patent, and how it has grown in a few years.

The Court: Yes.

Mr. Owen: And we were criticized, or the witness Mr. Penhaligan was criticized on cross examination because he had included in those figures certain treatments that were made for mud removal in the California field and some for stuck drill pipes, and Mr. Penhaligan, who is not a chemist and is the auditor there, in making up his figures included all of those because they went through his books as business for Dowell X. In view of the criticism we had Mr. Penhaligan go through his books again and take out all those California treatments and all the stuck drill treatments and things of that kind, and I would like to get this in by submitting it to counsel and avoid recalling Mr. Penhaligan, if that is possible.

The Court: Submit it to them and let them look at it.

Mr. Owen: Then Mr. Penhaligan has also made up a list of treatments made by licensees other than Dowell, which I would like to offer, and those are made up by months, beginning with the year 1934, and ending with the year 1940.

The Court: Have those marked right now and offer them and then I will wait and see what they say about it later on.

Mr. Owen: I will have the sheet showing the deductions from the figures shown on our chart PX-10 marked PX-232, and the sheet showing treatments made by licensees of Dow, other than Dowell, will be marked PX-233.

(The sheets were thereupon marked PX-232 and PX-233.)

Mr. Owen: We will hand these to defendant's counsel for study.

Mr. Owen: A couple of days ago we had identified as PX-232 and 233 two sets of data prepared by Mr. Penhaligan the first of which shows the figures of total treatments, which are included in PX-94; that is, the total treatments made by Dow and Dowell, and the question was asked whether it included certain mud treatments in California, and treatments for the removal of stuck drills, and I had Mr. Penhaligan recheck it and deduct treatments which related to the removal of stuck drills and the California treatments, and the corrected figures are given down at the bottom, opposite the words "Net total." I want to know whether defendant will stipulate that Mr. Penhaligan would testify to the correctness of these figures if recalled.

Mr. Lyon: If I understand it, on Exhibit 232 the individual jobs deducted from the previous figures which were on PX-94 represent jobs where the acidizing was not to increase the production?

Mr. Owen: That is right.

The Court: These are actual figures?

Mr. Owen: These are actual figures taken from our records.

Mr. Lyon: I am willing to agree that he would testify to these figures of these deductions if brought in, but in connection with that I would like to offer these two advertisements of the Dowell Company in connection with the importance and the character of the operations which were formerly included in Exhibit 94, and which now will be deducted from Exhibit 94.

Mr. Owen: I don't have any objection to that.

Mr. Lyon: The first one is entitled "Out In Front." It appeared in the Petroleum World for September, 1938, and it is entitled "Out In Front," and has an explanation, "Out in front with lime scale removal.

"Removal of lime scale is among the important specialized services Dowell has perfected expressly for California producers.

"Lime (calcium carbonate) scale presents a special problem well worth solving, as these deposits, led by water, block off producing formations and production declines abnormally.

"Dowell, after long study and practical field work, has perfected a special service that leaves nothing to guesswork. Dowell uses inhibited acid which protects metal liners, while rapidly dissolving calcium carbonate."

And I want the court to bear this in mind in connection with this, what the Gypsy did, which was read in evidence, down in Oklahoma, where they were doing exactly this, and Dowell is advertising this.

(The advertisement above referred to was thereupon marked Defendant's Exhibit No. 242.)

Mr. Lyon: I will now produce and ask to be marked as DX-243 a page advertisement of the Dow Chemical Company in the Petroleum World for January, 1939, the advertisement reading:

"Dowell scale removal treatment.

"For California producers.

"Dowell Chemical removal of carbonate scale increases profits.

"As indicated so graphically in the chart reproduced above, actual results obtained in numerous Dowell treatments for carbonate scale removal demonstrate the great value of this special service for California producers. It is a service that is proving itself, again and again, an exceedingly profitable investment for the operator.

"Dowell carbonate scale treatment and technique of

application have been carefully developed and perfected to meet conditions as found in California wells.

"Inhibited acid, to which a wetting agent is usually added, is pumped through the casing head into the annular space between the tubing and casing. The acid comes in contact with the scale both on the outside of the tubing and, still more important, on the perforated section of casing or liner.

"Treatments and technique of application vary according to conditions as tested and determined by Dowell technicians. And case histories tell the same story—restored production and increased profits."

We offer that, which on its face is obviously the same treatment that the Gypsy was using.

The Court: Except the inhibitor.

Mr. Lyon: Well, the Gypsy had the inhibitor in. You remember Dr. Wescott of the Mellon Institute recommended the inhibitor.

The Court: Yes.

Mr. Lyon: And they put the inhibitor in down in Oklahoma.

(The advertisement above referred to was thereupon marked Defendant's Exhibit No. 243.)

Mr. Owen: If Your Honor please, PX-233 is a statement prepared by Mr. Penhaligen, showing the number of treatments made by licensees of Dow under these patents, other than the Dowell Company, and that shows a total of 2277 treatments, and does not include treatments made by California licensees.

Mr. Lyon: I would agree that your witness would testify in accordance with this Exhibit PX-233, but in accordance with Exhibit 232, these deductions that have been made from Exhibit 94, am I correct, Mr. Owen, that you have deducted from Exhibit 94, in this Exhibit 232, the scale treatments, or the jobs that have been done in accordance with these last two advertisements that I have produced here; or are they still included in these figures that remain after the deductions appearing on Exhibit 232?

Mr. Owen: It is my understanding that they are excluded, but I will have that checked.

Mr. Lyon: Would you have that checked because I would like to know whether the figures that are presented here under the patent in suit include these lime scale removal jobs, or not. For obvious reasons, I think the court should know that.

The Court: He will produce that, and I will admit 232 and 233.

Mr. Owen: Now, in connection with depositions taken in this case in Duncan, Oklahoma, Mr. Clason produced a number of acidizing tickets which were marked in that deposition PX-7 and numbered from 1 to 113, there being a total of 113 tickets.

I wish to offer those tickets as an entirety here as PX-244.

(The defendant's acidizing tickets referred to were thereupon marked PX-244.)

Mr. Owen: Then I wish to call upon defendant to produce the orders relating to these particular jobs covered by these 113 tickets. The orders, I will say, contain information that is not contained on the tickets, and that is the reason I am asking for them.

Mr. Lyon: We haven't got them here. It would require a considerable work to go back through the records of the company and dig out all the orders which these tickets correspond to. The tickets were produced when they asked for them. They have never asked, as far as I know, for the orders, and I don't see how we can have them here now in time, and I don't think we should be asked to go get them. I don't understand the orders have any information on that the tickets haven't got. What could be the information you want? Maybe we can cover it in some other way.

The Court: These are orders from the customers?

Mr. Lyon: Yes; but these are the actual operations. I don't see where all these jobs come in on this case in any special way in this hearing. They are all the jobs ever done

in Michigan up to the filing of this complaint, and I can't see that those individual jobs are involved unless we come into an accounting, and what is the information you want off the orders? We want the court to have any information that the court wants, but to go find 113 orders through our books back four or five years ago, is a job. They don't really need them. What is it you want to prove by it? Maybe we can make some statement that we could prove—

Mr. Owen (interposing): We want to prove the depth of these wells and the length of the casing, the distance from the bottom of the casing to the bottom of the well, and the length of the tubing.

Mr. Lyon: Well, aren't you willing to accept the four wells which you took your samples from here as typical of what the defendant was doing here in this district?

Mr. Owen: Yes.

Mr. Lyon: You have that data for those four wells.

Mr. Owen: We have that, yes, for those four wells, and I can't answer that because I don't know whether it would be typical, but I will consider it, and in the meantime I would like to have you endeavor to get that information from your home office.

Mr. Lyon: We can't get it here. It would take considerable time. I am not sure how long. Probably a couple of weeks, to go through all the records. This stuff is all permanently separated in the files of the company, by oil companies. Now, these oil companies, for instance, like the Ohio Oil Company operates in many places in the United States. We would have to check through all of their orders to pick out those that came and were filed under their name from Michigan, and then they would have to be sent up here.

Mr. Owen: I am sorry you didn't understand my request. I thought I made it perfectly plain. I introduced photostatic copies of just what you have produced here today, and I requested at the same time that you produce these agreements.

Mr. Lyon: Well, I understood, Your Honor, that this

case was being tried on the basis that the four wells that the specific samples were offered from were typical of what they alleged was an infringement. Now, they have the data on those four wells.

The Court: Can't we get that, Mr. Owen, and see what that does show with reference to those four? Does that show you what you wanted to prove?

Mr. Owen: As to those.

The Court: If it does, for one well, and you agree that is typical of the others—

Mr. Owen (interposing): As to those four wells, it does show the information, and we will consider that this evening.

The Court: Was favorable to you.

Mr. Owen: I don't know whether it is favorable or unfavorable. All I want—

The Court: But I guessed the point to it, you want to show the acid would come in contact with the iron?

Mr. Owen: Right.

The Court: That is what you want?

Mr. Owen: Right.

The Court: Does it in those wells?

Mr. Owen: I think it does.

The Court: Well, then, say it is typical of the others, then you have shown you come in contact with all those wells, I take it?

Mr. Lyon: He means by "coming in contact," he wants to know how long it takes it to go down the pipe.

Mr. Owen: How long it is in contact?

Mr. Lyon: With the pipe going down.

Mr. Owen: The length of the tubing has something—

The Court: On that now he says he is willing to take those four as typical of how long they take, and those are the four—they did not make them out, I don't reach the conclusion that they have selected those that will show the best for them.

Mr. Owen: Your Honor, I have some figures here that have been gotten up from the books and records of the Dow

and the Dowell companies, regarding their advertising expenditures during 1932, 1933 and 1934, and also as to the amount of business transacted in this acidizing business during those years. I would like to read them in the record, with the understanding—

Mr. Lyon: I have not seen them before, and I do not know what they are.

Mr. Owen: I will defer that then with the understanding that I may put it in later. I will get a witness here who will prove it.

The Court: You can put it in later then.

Mr. Owen: Yes, I can put it in as part of my rebuttal.

The Court: Yes, or at any time I will interrupt the other side long enough for you to put it in, if you want to. I will make it that convenient for your witness. While I like to have a plaintiff, when they are putting in their proof, put in all they have got in mind, and the defendant all they have in mind, why, if something is overlooked, I want them to put it in later, if they discover that something has been overlooked. I don't want you, for instance, in announcing that you have rested here to be uneasy for fear that you have forgotten something. Any time before the final decree will be time enough.

Mr. Owen: Yes, Your Honor. The next thing I have is a printed price list, or, it is called service price schedule 110 of Dowell, Inc., which became effective June 23, 1937, and I am offering it for the purpose of showing that the blanket service, the jelly seal service and the surface tension reducing agent were not charged for within certain limits. For instance, the Dowell X is inhibited hydrochloric acid solution. Dowell XF is Dowell X, with the surface tension reducing properties for use in low pressure wells; and the charge item No. 4—no, item No. 1, is 500 gallons or less Dowell X or XF service. Then it gives the price of the treatment. There are three different classes here, evidently for different locations, and that is all on the price list, so I won't read it.

(The price list referred to was thereupon offered as PX-245.)

Mr. Owen: Now, the only other exhibits I want to offer in connection with my prima facie are two sets of tables that Dr. Bartell furnished to Mr. Lyon, at his request, and I would like to offer this set in connection with the copy of Dr. Bartell's letter to Mr. Lyon dated August 4th, which states:

"Acting upon your request I am sending you herewith the experimental data which was obtained in our acid corrosion tests with samples numbered 1 and 2 from the Stella Wilcox Well." I will offer that carbon copy of the letter and the four sheets of data as PX-247.

(The document above referred to was marked PX-247.)

Mr. Owen: I offer as PX-248 carbon copy of the letter written by Dr. Bartell to Mr. Lyon August 4th, reading as follows:

"Acting upon your request I am sending you herewith the experimental data which was obtained in our acid corrosion tests as presented in and described in our Table XIX (PX-167)," and attached to that copy are 3 sheets of data.

(The document above referred to was marked PX-248.)

Mr. Owen: That closes my prima facie case, Your Honor, with that reservation I made, which you granted.

DEFENSE PROOFS

DON HATHORN,

a witness called by defendant, testified as follows:

I am an engineer in the employ of the defendant, Halliburton Oil Well Cementing Company and live at Duncan, Oklahoma. I have been for some time in the Patent Department of that company, assist the Patent Department in making tests and tabulating data. I have conducted certain tests for this case with reference to the operation of the Menaul method of protecting the tanks employed by the defendant in acidizing oil wells. Assisting me in these tests I had Menaul in at different times, and I had four different assistants from Halliburton laboratory, working under my supervision. They were Frances Anderson, George Mirham, Bill Barrett and Zema Ballinger. The work they did was done under my supervision and recorded under my supervision. All of this work—that was done by my assistants and by me personally—was recorded at the time it was done in certain books of original entry. I have those books here and will produce them.

(Witness produces books.)

Everything is recorded in this, but some titration numbers are in here (indicating another book), but they are transferred to this book (indicating).

Mr. Lyon: The book which the witness has just identified is offered as DX-277.

(The book referred to was thereupon marked DX-277.)

I might say that there are some other data in there which do not relate to this lawsuit (indicating) but all of the actual determinations made in the tests on the Menaul tank conducted by me, or under my supervision, are entered in this Exhibit DX-277. This is the book of original entry of those tests.

(The second book referred to was thereupon marked DX-278.)

This book was used in recording some of the titrations, but being as this other book was in use on other experiments that were going on at the time, they were recorded in this second book, and then transferred to the first book. By titrations I mean the chemical tests as distinguished from the weighings and readings which are in 277. These titrations were recorded in 278 as the book of original entry, and then they were transferred to 277. I have taken the readings and titrations recorded on Exhibits 277 and 278, and plotted the results of the various experiments in the form of curves, and in doing so I made certain calculations. I have the book in which I made the calculations (producing a book).

Mr. Lyon: I will ask that this book be received and marked DX-279.

(The book referred to was thereupon marked DX-279.)

Mr. Lyon: I will ask that the first one of these curves, entitled "Hard steel tank No. 1," be marked DX-280.

(The curve referred to was thereupon marked DX-280.)

Mr. Lyon: That is the first sheet. The various sheets are all attached together. The second sheet is marked "Hard steel tank No. 2." I will ask that that be marked DX-281. The next sheet is marked "Hard steel tank No. 3." I will ask that it be marked DX-282. The next sheet is marked "Soft steel tank No. 4. Sheet 4." I will ask that it be marked DX-283. The next sheet is marked "Soft steel tank No. 5. Sheet 5." I will ask that that be marked DX-284. The next sheet is entitled "Hard steel tank No. 1. Sheet 6." I will ask that that be marked DX-285. The next sheet is entitled "Soft steel tank No. 4. Sheet 7." I will ask that that be marked DX-286.

(The sheets referred to were thereupon marked DX-281 to DX-286.)

These various curves that appear on Exhibits DX-280 to 286, respectively, were drawn by me from the data observed in the experiments recorded in Exhibits DX-277,

278, with the calculations in Exhibit 279, and to the best of my ability they correctly set forth graphically the results of the experiments recorded in those exhibits. I have an index prepared which will enable anyone interested to readily find in Exhibits 277, 278 and 279 the various values which are plotted on the curves, Exhibits 280 to 286 (producing document). It is entitled "Index for corrosion experiments."

Mr. Lyon: I will ask that that be marked DX-287.

(The index referred to was thereupon marked DX-287.)

Mr. Lyon: Will you take these different sheets, identify them by exhibit number, and tell us what the experiments were, briefly, the results of which are plotted in the individual curves appearing on the sheets, because, as noted, each one of the curves on each sheet is numbered so that they can be found on the index? First, Exhibit 280, curve No. 1; what is that curve? A. It is a curve of commercial acid placed in an iron tank, steel tank, which is made of the same material as the defendant's truck tank, and the solution of hydrochloric acid was agitated and samples taken at each one of these points along the curve and the test continued for about 42 hours. I have the tank that was used in that test. The tanks are over here (indicating). This (indicating) is hard steel tank No. 1.

Mr. Lyon: I will ask that that be marked DX-288.

(The tank referred to was thereupon marked DX-288.)

The other tank is what we call "Soft steel tank." That was used in the soft steel tank experiments. We had two soft steel tanks, No. 4 and No. 5; this is No. 4. We had three hard steel tanks, Nos. 1, 2 and 3, and this is tank 1 (indicating).

Mr. Lyon: We ask that the soft steel tank produced by the witness be marked DX-289.

(The tank referred to was thereupon marked DX-289.)

The soft steel tank, Exhibit 289, is made from material corresponding to well pipe. Well pipe is made out of soft steel. This was to show the action of acid in my tests on oil well pipe, on the iron used in well pipes.

The Court: Both the casing and the tubing? A. This happens to be a piece of casing, sixteen inch casing. We didn't use tubing because it would be too small. And the hard steel tank Exhibit 288 was made from hard steel and the defendant employes hard steel in its truck tanks. This is a piece of the steel.

Mr. Lyon: So as to show the effect of acid on the kind of steel that is used in the truck tanks as distinguished from the pipe.

The Court: Fine.

Mr. Lyon: Now let's get back over to the curves. Now, will you describe the experiment made the results of which are recorded in Curve No. 1 on Exhibit 280, just briefly, so we can tell what kind of experiment it was? A. Well, Curve No. 1 was a plain commercial hydrochloric acid placed in the hard steel tank No. 1 and agitated with the motor you see sitting on the tank over there, and a glass stirring rod used, for agitation, the R.P.M. of the stirring rod was about sixty revolutions per minute. And at each one of these points you see on the curve here a sample was taken, and an analysis for iron was run on that particular sample and recorded there, the amount of iron in ounces per thousand gallons of acid solution was calculated and plotted, versus time in hours. Also, I have a scale here which is iron content of acid solution in parts per million by weight, which was put on there to correspond to the values that the plaintiff gave us in their answers to interrogatories.

Q. Now, in making the test the numbers of which are plotted in the Curve No. 1 on Exhibit 280, did you have any lead plate bonded in the Tank No. 1? A. No lead plate at all in contact.

Q. Then this curve No. 1 on Exhibit 280 is a curve showing the rate of corrosion or dissolution of the hard steel tank in the absence of any lead plate using commercial hydrochloric acid; is that correct? A. That is correct.

Q. And that commercial hydrochloric acid is the same kind and make of acid as the defendant employes in its

acidizing operations? A. Yes. All these tests were run with fifteen per cent acid.

Q. All right. Now tell us what curve No. 2 is: A. Curve No. 2 was run in the exact procedure, however it was a different date. Curves 1, 2 and 3 were all run in the large steel tank No. 1 without any lead plate. As near as we could tell, exactly the same procedure. 1, 2 and 3 were run the same. They weren't the same acid. They were out of the same shipment of acid.

Q. I understand that you use one acid for the test, then you take another batch of acid for the second curve, is that right? A. Yes. Same base acid, same shipment.

Mr. Lyon: That shows, Your Honor, the three curves rather than an average. In that particular case, the three results instead of an average.

Mr. Owen: What make acid was it? A. Well, I just turned over to the purchasing department and told them to order so many carboys of the same acid we used in the field. I believe in that case it was Grasselli acid. I don't know.

Mr. Richmond: Mr. Clason can give the name.

Mr. Clason: Grasselli Chemical.

Mr. Lyon: You mean all these curves were made by the same Grasselli acid? A. Yes.

Mr. Owen: The same tank used for these tests, curves 1, 2 and 3? A. All on this sheet were made in one hard steel tank, and then we had three different sheets for three different tanks.

Mr. Owen: And the same shipment of acid? A. Yes, sir.

Mr. Lyon: Unless otherwise specified, you used the same shipment of acid for making all these tests? A. Yes.

Mr. Lyon: Now, I don't think I need to go into the date of the runs because they are all tabulated in Exhibit 285.

Mr. Wiles: The variation isn't attributable to temperature change at the different dates? A. Well, it might be because the same temperature might not prevail last Feb-

ruary in the building as it did this summer when we finally wound up the tests.

Q. (By Mr. Lyon): Now, curve No. 1, according to Exhibit 285 was made on March 31, 1941, Curve No. 3 made on March 5, 1941, Curve No. 2 was made on June 10, 1941. This was an air conditioned room in which these tests were made, is that correct? A. Yes. However, the temperature would vary from night and day too, you see.

Q. Well, these tests were run continuously, were they not, the number of days that your curve indicates? A. Yes.

Q. And are these the dates at the start of the runs? A. Yes.

Q. So Curves number 1 and 3 were both started in March, were they not? A. They are marked.

Q. And in that air conditioned room in your country there wouldn't be much difference in temperature as compared with one day in March to another, would there? A. No.

Q. And how much difference would there be in your air conditioned system between a date in March and a date in June in that room, if you know? A. I would say not over 5 or 10 degrees.

Q. Now will you take up Curve No. 4 on Exhibit 280 and tell us what that is? A. Curve No. 4 was commercial acid with a lead plate bonded to the side of the tank, as you see by the exhibit.

Q. Will you explain the bonding of this lead plate in Exhibit 288, which is a hard steel tank. Is the lead plate in the exhibit now bonded as it was in the test? A. It is. The lead plate that is bonded to the steel tank is the same —has the same surface exposed to the acid relative to the iron surface as the lead plate used in the defendant's truck tank (indicating). The lead plate was insulated by rubber stoppers from the bottom of the tank.

The Court: Is the lead in this tank exposed on both sides or on one side?

Mr. Owen: On both sides. A. After these experiments with the lead plate were run for twenty-four hours, the lead

plate was cut across here, the top, and then a stand was moved up and this lead plate was clamped in the acid, but not in any way connected to the steel tank, so as to leave the plate suspended in there, but no electrical contact except through the electrolyte.

Q. Now, this lead, what did you order, or, how did you get this lead plate; what kind of lead is it? A. It is the sheet lead just cut out of a piece of sheet which would ordinarily be used in the defendant's tank.

Q. Do you know what grade of lead it is? A. No; it is just the commercial lead.

Q. At the time you made these tests did you have any information, or anything which caused you to believe that the plaintiff in this case was relying on copper acting as an inhibitor in the Menaul system and there was any claim that there was copper in the lead or in the tank surfaces? A. No, I didn't.

Mr. Wiles: After you cut off the lead plate, how did you say it was held when the further tests were made? A. We moved a stand similar to this up here (indicating), and clamped this lead plate to the stand, metal stand.

The Court: Was that metal in contact with this part (indicating)? A. No, it wasn't, it was setting out here on the wooden table, you see.

Mr. Lyon: So what you did—we will point out the curves where you did it, and the end of twenty-four hours in these tests you disconnected the lead plate from the steel? A. Yes.

Q. Just to show what effect it made on the continued running when it was disconnected?

The Court: A good way to find out. All right.

Q. (By Mr. Lyon): Now, this lead plate in Exhibit 289 is subject to the same testimony and the same explanation? A. Yes.

Mr. Wiles: That is the soft steel tank? A. Yes.

Mr. Lyon: And these tanks, Exhibits 288 and 289, haven't been altered in any way as to their surface condition since you ran the experiments that your exhibits report? A. Except that they have rusted a little.

Q. They have rusted a little since then, but I mean you haven't done anything, burnished them or polished them or removed any corrosion, or anything of that kind? A. No.

Q. And any pitting that existed as a result of any of those experiments is still there? A. Yes.

Mr. Wiles: Do you have the composition of the steel in these tanks? A. No, I don't have.

Q. (By Mr. Lyon): But they are in the regular well pipe and the regular tank steel? A. That is right.

The Court: What did you do, take a casing and split it open and weld it on? A. We took a piece of 16-inch casing and cut out this piece about 14 inches high and then took a piece of the same material and made the bottom, welded the bottom in. It is the same material as the casing.

The Court: You took just one casing and cut it off and put the bottom in? A. Yes.

Mr. Lyon: How did you make the other hard steel tank, Exhibit DX-288? A. It was made out of a piece of flat steel, came out of the same stock as they make the defendant's tanks.

Q. How about the welding rods that were used? A. It was the same material as the tank itself.

Mr. Owen: Are the two tanks of the same capacity? A. Yes.

Mr. Lyon: And you used a lead plate in each case whose exposed surface relative to the exposed surface of the tank would exactly correspond to that relation in the defendant's truck tanks? A. I don't know whether it would be exactly or not. As well as we could calculate it.

Q. I mean, you calculated it, and, to the best of your ability, that is the relation? A. Yes.

Mr. Allen Owen: I would like to ask a question about the bottom of this soft steel tank. Where did you get that material? A. Out of a piece of casing.

Mr. Allen Owen: You took a piece of casing and flattened it out? A. Flattened it out.

The Court: Flattened out a piece of the same casing and then cut it out? A. That is right.

Mr. Wilber Owen: Did you heat the steel to flatten it? A. No. I don't know how they flattened it. They have hammers there in the shop.

Q. (By Mr. Lyon): They have big hammers down there that could easily flatten out one of these pieces without heating it, couldn't it? A. Yes.

Mr. Wilber Owen: You know that they didn't heat it? A. What they did, they took a welding torch and just cut the casing in two and then put it under the hammer and flattened it out. Yes; I am sure they didn't heat it.

Mr. Lyon: All right. Now, can we go back to curve No. 4 on Exhibit 280, and tell us how you made the test plotted on that curve? A. We ran the commercial acid with the lead plate bonded to the tank for twenty-four hours, taking samples, and at the end of twenty-four hours we disconnected the lead plate and left it suspended in the solution, insulated from the iron tank I described previously, and then took samples for an additional twenty-four hours.

Q. In preparing these curves, you have actually placed on the sheets the dots or points which your results or your measurements actually show, and by noting on these curves the dots you know exactly what readings and what calculations you made, is that right? A. Yes, sir.

Q. It is only necessary by means of this index to find in Exhibit 277 the values and the calculations that result in those particular readings? A. Yes, sir.

Mr. Owen: I would like to ask at this point whether you made any corrosion tests in those tanks without any lead plate connected with them? A. Yes. One, two and three were made without the lead plate. 4, 5 and 6 were made with the lead plate in.

Mr. Lyon: You have explained curve No. 4. Tell us how the test was run on which curve No. 5 was based? A. Curve No. 5 was run in the exact procedure as curve No. 4.

Q. How about curve No. 6? A. Curve No. 6 was the commercial acid, plus the Tergitol, which we originally felt might have been classified as an inhibitor, and it was run

with the lead plate connected for twenty-four hours, and then the lead plate was disconnected.

Q. This legend on Exhibit 280 reading "Lead plate disconnected, tank not cleaned," pointing to curves 4, 5 and 6, is to indicate that at the end of the twenty-four hours the plate in those three experiments was disconnected, and then the experiment continued with the lead plate suspended, and not connected, and without stopping to clean the tank? A. Yes.

Mr. Allen Owen: Was the tank cleaned between runs? A. Yes, it was.

Mr. Allen Owen: How? A. By putting in boiling sulphuric acid, and it staying in there about between 45 and 50 minutes, and at frequent intervals they would take it out, and if there was any contamination visible, they would brush it out with a wire brush; and then it was rinsed out with hot water, and then rinsed with hydrochloric acid.

Mr. Owen: How much Tergitol did you put in that last experiment? A. It was two-tenths of a per cent by weight.

Mr. Conner: Which Tergitol did you use for the last curve? A. Tergitol 4.

Mr. Lyon: At this time, in order that Your Honor may not be worrying about something that you don't need to worry about, I would like to read in evidence the answer of the plaintiff to interrogatory No. 7 proposed by the defendant to the plaintiff, and this was subscribed and sworn to on June 2, 1941, and reads:

(Reading): "7. Answer to Interrogatory No. 7. Plaintiff will not contend that the presence of 'Tergitol' in the acid solutions used by defendant in treating oil wells constitutes infringement of Grebe and Sanford patent No. 1,877,504."

Mr. Lyon: Will you explain the test by which the various curves occurring on this exhibit was made? A. These curves were made on tank No. 1 which was a hard steel tank, made similar to this other tank. Curve No. 1 was commercial acid, with no lead plate. Curve No. 2 was

commercial acid plus Tergitol, .2% by weight, with no lead plate.

Q. The first one is just the acid without any lead plate; the next with Tergitol without any lead plate at all? A. Yes. Curve No. 3 was commercial acid plus lead plate, with the lead plate disconnected after 24 hours. That was, it was cut and taken out, acid removed from the tank this time, and the tank thoroughly cleaned. And then the lead plate suspended back in the acid, the acid put back in the tank and the lead plate suspended.

Q. But not connected? A. Not connected in any way.

The Court: In other words, that means to me, as I look at it there, as quick as the lead was disconnected the acid went to eating the iron? A. The reason for cleaning this tank was to remove polarization or lead that was deposited on the steel tank.

Mr. Owen: Did you change the acid at that point? A. It is the same acid. Removed from the tank, placed in a crock, and after the tank was cleaned it was poured back into the tank.

The Court: Of course they cleaned it, so that if the others had done a good job, and all you claim for it, it might have such a coating on that it at least would take it some time to get started? A. Yes. Here (indicating) curve No. 4 is run in the same way, except the tank wasn't cleaned, and the curve came on out and eventually went up.

Mr. Lyon: What about curve 5? A. Curve No. 5 is commercial acid with lead plus Tergitol and the lead plate disconnected after twenty-four hours and the tank cleaned the same way as curve No. 3.

Mr. Lyon: The reason for these Tergitol duplications, Your Honor, the plaintiff doesn't contend the Tergitol is an inhibitor in measuring any claimed inhibitors or rate of corrosion in the defendant's acid; in order to be paralled with what the defendant uses; the Tergitol should be in there, because it is in the acid the defendant employs.

Q. (By Mr. Lyon): Now, will you turn over to the next exhibit, Exhibit 282, and explain the curves on that

exhibit? A. Curve No. 1 is commercial acid. This is a hard steel tank.

Q. No. 3? A. Yes; with no lead plate. Curve No. 2 is commercial acid plus arsenic trioxide. In the same tank. No lead plate. Curve No. 3 is commercial—

The Court: In other words, that is the patent? A. Yes.

The Court: All right. A. Curve No. 3 is commercial acid plus lead plate, connected up to twenty-four hours, and then the lead plate disconnected, but the tank not cleaned.

The Court: Ran straight on for a little while, they would have got rid of what was on the walls and then up they went. A. Yes. Curve No. 4, commercial acid plus lead plate, and at the end of twenty-four hours the lead plate was disconnected and the tank cleaned. Curve No. 5 is commercial acid plus Tergitol with lead plate connected for twenty-four hours. At the end of twenty-four hours the tank was not cleaned after the lead plate was disconnected.

Mr. Wiles: How was the tank cleaned? A. As I stated before, it was suspended in boiling sulphuric acid and then at frequent intervals they would raise the tank out and scrape it with a wire brush, and then at the end when it was taken out of the sulphuric acid it was lowered into boiling water and rinsed and then was rinsed with hydrochloric acid.

Mr. Lyon: Now, these three sheets, Exhibits 280, 281 and 282 are, in effect, a repetition of the same experiments, but using three different hard steel tanks? A. That is right.

Q. Just to show the results so that they may be seen to what extent they are consistent, using three tanks all made out of the same hard steel? A. That is right.

The Court: Like this one (indicating); have we got one of the three here? A. Yes, this is No. 1 (indicating).

The Court: The other two are not here? A. That is right.

Mr. Lyon: Now, will you turn to Exhibit 283 and ex-

plain the tests which resulted in those curves? A. This is a soft steel tank, No. 4, that we have here in the court room, and curve No. 1 is commercial acid, no lead plate. Curve No. 2 is commercial acid with no lead plate. Both of them were run for twenty-four hours. And, curve No. 3 is commercial acid plus lead plate, with the lead plate disconnected at the end of twenty-four hours and the tank not cleaned. Curve No. 4 was commercial acid plus Tergitol, plus lead plate, with the lead plate disconnected and tank cleaned after twenty-four hours. Curve No. 5 is commercial acid plus lead plate with the lead plate disconnected and tank cleaned after twenty-four hours. Curve No. 6 is commercial acid plus lead plate, plus Tergitol, with the lead plate disconnected and tank not cleaned at twenty-four hours.

Mr. Conner: Will you explain curve No. 4 with reference to curve No. 6? A. Curve No. 4 and curve No. 5 for the first twenty-four hours should be the same. They are commercial acid plus lead plate plus Tergitol. Curves 4 and 6 were run in the exact procedure, same procedure.

Mr. Conner: How do you account for that difference there, or can you? A. I can't; your explanation is as good as mine, I suppose. Curve No. 7 is commercial acid plus arsenic trioxide.

Mr. Wiles: I didn't understand which one of those had Tergitol in. A. Curve No. 4 and curve No. 5 was commercial acid plus Tergitol, plus lead plate connected for twenty-four hours. There was no difference in the materials used, or in the technique followed in curve No. 4 and curve No. 6. As far as we could tell, we carried out the exact same procedure.

Mr. Wiles: The same tank. A. The same tank, and curve No. 4, we got a much higher result than we did in curve No. 6, and I cannot account for it.

Mr. Conner: Which was first, curve 4 or curve 6? A. Curve 4 was 4/29/41; curve 6 was 4/22/41.

Mr. Wiles: Curve 6 was before the curve 4? A. Yes, a week before.

Mr. Conner: What did you do with that tank in between the time you ran the data as plotted on curve 7 and the time you ran the test as reflected on curve 4, what did you do in between those two tests? A. You mean what other curves I ran?

Mr. Conner: That, and what else did you do to the tank, if anything? A. Just cleaned it.

Mr. Lyon: You don't want to know about the other experiments he was running? They are all listed on this index.

Mr. Owen: In between those two dates, I would like to have the experiments pointed out.

Mr. Lyon: On this particular tank and not on the other tanks. A. As shown here, there was no other experiments run on this tank between the 22nd and the 29th. It just set idle. And then when we started to run curve No. 4 we cleaned the tank with the same procedure we had cleaned it before.

Mr. Conner: From running curve 4 as you testified and getting that value to running curve 6 as you testified and getting that value, I don't think you have got any reproducible curves there at all. A. Neither do I.

Mr. Lyon: You don't think you can make them, either? A. No.

Q. Now, will you turn over to Exhibit 284. Explain the tests which are graphically shown on that exhibit. A. This is soft steel tank No. 5; curve No. 1 is commercial acid plus Tergitol with no lead plate. Curve 2 and curve 4 are commercial acid—two duplicate runs without Tergitol, without the lead plate. And curve No. 3 and curve No. 7 was commercial acid plus lead plate plus Tergitol. For the first twenty-four hours they should be the same.

At the end of twenty-four hours, curve No. 7, the lead plate was disconnected and tank cleaned, while in curve No. 3 at the end of twenty-four hours the lead plate was disconnected and tank not cleaned. And curve No. 5 was commercial acid plus lead plate, and at the end of twenty-four hours the lead plate was disconnected and tank not cleaned.

Curve No. 6 was commercial acid plus lead plate, which was the same for the first twenty-four hours as curve No. 5, run in exactly the same procedure. At the end of twenty-four hours the lead plate was disconnected and tank cleaned. Curve No. 8 is commercial acid plus arsenic trioxide.

Mr. Owen: Is that the little short one? A. Yes.

Mr. Lyon: That was run for twenty-four hours? A. Twenty-four hours.

Mr. Owen: And how much arsenic trioxide did you put in that? A. One per cent.

Mr. Babcock: I think the witness made a slight error there, comparing curves 5 and 6. In one you had Tergitol and the other you didn't, did you not? A. No. The first had "Tergitol" there, but it is crossed out.

Mr. Conner: Shouldn't be there; is that correct? A. Shouldn't be there. "Tergitol" shouldn't be there.

Q. (By Mr. Lyon): Now, will you turn to the next sheet, and explain the tests that are graphically reported on this sheet. This is back again to a hard steel tank now? A. Hard steel tank No. 1. With sheets Nos. 6 and 7, we ran those after we had received the answer to the last set of interrogatories, where the plaintiff claimed copper as an inhibitor. Curve No. 1 is commercial acid, plus iron, lead, and copper added in the same amounts as claimed to be the analysis of the acid from the Zahn well. Curve No. 2 was commercial acid—I mean, C. P. acid, plus copper, the same amount, 3.1 parts per million. Curve No. 3 was the C. P. acid by itself. Curve No. 4 was C. P. acid plus lead, in the same amount as used in the Zahn well. Curve No. 5 was commercial acid without lead, and without anything added.

Mr. Allen Owen: That compares then with curve No. 3? A. No. Curve No. 3 is C. P. acid, chemically pure acid. Curve No. 5 is commercial acid.

Mr. Owen: What was curve No. 1? A. Curve No. 1 is C. P. acid, plus iron, plus lead, plus copper added in the same amounts as disclosed in the Zahn well, the acid used in the Zahn well.

Mr. Lyon: Have you explained all of these curves? What about No. 5 down there? A. No. 5 is commercial acid. No. 6 is commercial acid plus iron plus lead plus copper added in the same amounts as used in the acid in the Zahn well; the same amounts were added as in curve No. 1.

Q. Then the difference between curve No. 1 and curve No. 6, although those are duplicate experiments, or parallel experiments—or are they? A. All except that in curve No. 1 chemically pure acid was used, and in No. 6 commercial acid was used.

Q. Let us turn over to the next exhibit, 286. This is back again to the soft steel tank No. 4? A. Yes.

Q. What number is that soft steel tank? A. No. 4 is the one that we have here in the court room.

Q. These tests were made on the tank that is here in the court room? A. Yes.

Mr. Owen: What was the tank used in 285, was that hard steel or soft? A. That was hard steel, tank No. 1.

Q. All right, now will you explain these tests on which these curves were based? A. Curve No. 1, commercially pure acid plus lead.

Q. How much lead? Tell us the amount. A. The same amount that was given in the analysis on the Zahn well.

Q. The plaintiff's analysis? A. Yes.

Mr. Lyon: They reported in interrogatories, Your Honor, these amounts of lead, copper and iron which they found in these tank samples they took on these various wells, and they gave us that data.

The Court: And the witness prepared it synthetically the same as they did?

Mr. Lyon: That is right. I just want to see the date it was.

Mr. Babcock: The second day of June, 1941.

Mr. Lyon: That was June 2, 1941. That is the first time any of us had any idea, any suspicion, or hint they were going to claim there was copper in this system.

Q. And you made these experiments on 286 after we received that information as shown by Exhibit 285? A. They were made in June and July, Your Honor.

Q. Now, will you explain 286? A. Curve No. 2 is commercially pure acid with no iron, lead or copper or anything. Curve No. 3 is commercial acid as is used by the defendant. Curve No. 4 is a chemically pure acid plus copper, the same amount as given by the analysis in the Zahn well. Curve No. 5 is chemically pure acid plus lead, iron and copper in the same amounts used in the Zahn well. Curve No. 6 is commercial acid plus iron, lead and copper, the same amount as that used in the Zahn well.

Q. Now, just for a brief explanation of all these sheets of these curves, wherever the curve tends to go up more nearly as a vertical line, that means a higher rate of corrosion? A. Yes.

Q. And wherever it tends to lay down on a horizontal line, that means a lower rate of corrosion, isn't that right? A. That is right.

CROSS EXAMINATION

By Mr. Owen:

Q. Did you include in these charts, Exhibits 280 to 286, all the test runs that were made in these tanks that you have produced in evidence, and also all those which were run in duplicates of those tanks? A. No, I didn't; there are some curves at the first where I didn't pay any note to the tank number. I first started out with tank No. 1 and then I used another tank. When I started on tank No. 2 I didn't have the tanks numbered, and there was some there that I couldn't tell on which tank they were run, and they were left out. However, I think they will correspond to the curves that are shown. And then there are some others that were run using Petrowet instead of Tergitol, and there are one or two there with the C. P. acid where, after 24 hours, say I had been running lead in the C. P. acid, well, after 24 hours I would just put the same amount

of copper that was used in the Zahn well in the same solution and run it some more to see if it changed it any. That was just a preliminary experiment.

Q. That is not included? A. It is all in the data book, but it is not—all of it isn't in the curves on the curve sheets.

Q. Your data books contain every test that you ran? A. That is right.

Q. With any of these tanks? A. That is right.

Q. Now, how many of these hard steel and soft steel tanks did you make a test of? A. We had three hard steel tanks, that was tanks Nos. 1, 2 and 3; and two soft steel tanks, tanks Nos. 4 and 5.

Q. Were they all made at the same time? A. Yes—no, not all at the same time. Tank No. 1 was made first.

Q. That is of the hard steel? A. That is a hard steel tank. Then tank No. 2 next; and then tank No. 3. I can tell you when all of them were completed, when we had all five of them made. You can tell by the date of the test in here, when the tank was first run (indicating).

Q. How much time elapsed between the making of these different tanks? A. Tank No. 1 was made on or shortly before February 24th.

Q. Where did the material come from for that tank? A. It came from the same stock, from the sheet metal that was in stock that the defendant's tanks was made of, and this was cut out of a sheet of that.

Q. You mean your defendant's truck tanks? A. Yes.

Q. You make your own truck tanks, do you not? A. No, the Duncan Tank & Welding Company makes the truck tanks.

Q. Who puts the lead plates in them? A. We put the lead plates in. In getting the steel that I used for making these tanks I went to the Duncan Tank & Welding Company and told them what size tanks I wanted made up. I told them that I wanted them made up of the same steel, the same procedure in welding as we used in our truck tanks.

Q. Who determined the size of these exhibit tanks, and the shape of them? A. As I recall, Mr. Clason and Mr. Babcock and I had a conference, and decided what size tanks we would use.

Q. How many gallons do they hold? A. 11.4, I believe it is.

Q. How much acid did you put in each tank in each test? A. That was the amount of acid that we put in, which left the acid about half an inch, between a half and three-quarters of an inch from the top of the tank. We used the same amount of acid in each test.

Q. When did you make the second tank? A. The second tank was made about March 10, 1941. All this is in 1941. The first tank was made on or shortly before February 24th. The second one was March 10, in the neighborhood of March 10. I don't know whether it was on, before or after.

Q. And you told them you wanted the same thing? A. Yes.

Q. When was the third made? A. The third was made on or shortly before March 19. That is the first test that I have recorded for that tank, and it was made shortly before that. Both of the soft steel tanks Nos. 4 and 5 were made at the same time and at the same place and it was on or about April 2nd.

Q. Did you tell them how they were to be made? A. I told them to make them all out of the same material, what I mean is the soft steel tanks, out of well casing, 16-inch well casing.

Q. And the bottoms of all these tanks were welded in, were they not? A. Yes.

Q. Have you any analysis of this steel, either the hard steel or the soft steel? A. No, I do not.

Q. Now, you stated that you bought commercial acid from the Grasselli Chemical Company in carboys for use in these tests? A. Yes.

Q. And did you use more than one batch of—or more than one purchase? A. Of carboys, yes.

Q. How many? A. First we—the first order, we did not think we would run so many experiments, and, as I recall, we ordered about six or eight carboys, and then after we ran those we saw we were going to have to run some more experiments, and the last order, I believe, was for fifteen carboys.

Q. Do you know whether those came from the Cleveland plant of the Grasselli Chemical Company? A. No; I don't.

Mr. Clason: I don't exactly know the source, but I understand most of their acid is made up there.

Mr. Owen: Now, in this cleaning operation which you described, you stated that you used sulphuric acid. A. Yes.

Q. Where did you get that? A. I don't know where it came from. I got it—we have a plating shop, and they keep a sulphuric acid bath there. A plating shop.

Mr. Lyon: They have sulphuric acid they use in that plating shop? A. Yes.

Mr. Lyon: You went over there and got some of that? A. Went over and used the sulphuric acid bath to clean the tanks.

Mr. Owen: Did you dip it out of the acid bath, for the purpose, that is, out of the pickling bath? A. No.

Q. Did you get it yourself? A. No. Put the tanks in the sulphuric acid bath.

Q. Just as though you were pickling them; is that right? A. I don't know whether you would call it pickling or not.

Q. You submerged these tanks in that pickling bath, did you? A. Yes, in the sulphuric acid.

Q. Now, what do you use that tank for? A. Cleaning surfaces of metal.

Q. For getting them ready for plating? A. Yes.

Q. And how long did you leave these tanks in that pickling bath? A. Well, it ranged from about forty-five minutes to an hour.

Q. That was boiling? A. Yes.

Q. And what did you do after you took the tanks out

of the pickling bath? A. We rinsed them in hot water, and then we rinsed them with hydrochloric acid.

Q. What strength of hydrochloric acid? A. Fifteen per cent.

Q. You poured some hydrochloric acid in the tanks and sloshed it around, is that what you mean? A. Well, we rinsed them by just pouring hydrochloric acid in.

Q. Filling the tank and then— A. (interposing): We didn't fill the tank.

Q. How much did you put in? A. We put in about a gallon.

Q. Was that this same hydrochloric acid you were using in these tests? A. Yes.

Q. Poured out fresh acid from the carboys? A. Yes—no, we diluted it, of course.

Q. You diluted it to fifteen per cent? A. Yes.

Q. Now, who prescribed this cleaning operation? A. George Mahlin there in the laboratory.

Q. Who is he? A. He is the chemist in the Halliburton laboratory.

Q. Do you know what that pickling bath contained? A. Sulphuric acid.

Q. Anything else that you know? A. That is all that I know of.

Q. You don't know the composition of that sulphuric acid, do you? A. It was ten per cent, as I recall.

Q. How did you get that information? A. That is what Mr. Clason told me.

Q. That is, Mr. Clason told you that the pickling bath was a ten per cent sulphuric acid; is that right? A. Yes, sir.

Q. Do you recall what kind of tank that was in? A. It was in a steel tank, as I recall.

Q. You don't know whether it had any other ingredients in it besides that sulphuric acid? A. No, I don't.

Q. You have no sample of it? A. No.

Q. You never had a sample of it analyzed? A. No.

Q. Do you recall whether that pickling tank was unlined or lined? A. I wouldn't know whether it was or not.

Mr. Lyon: All these tanks were put in that same bath in the different operations in cleaning the tanks, weren't they, so whatever the bath did to the tanks it did to all the tanks each time they were cleaned? A. Yes, with the exception of about the first two or three that we didn't put in the sulphuric acid bath. Then we decided we would put them in there so they would all be cleaned in the same procedure.

The Court: Those are in your notes but not on the curves? A. Yes.

Mr. Owen: Now, these cleaning operations took place at different dates over a period of how many months? A. The first test was run from February 24th until about the first of July, I believe.

Q. And whenever you finished a test with one of these tanks, it was taken out and put through this cleaning procedure which you have explained? A. Yes.

Q. That is, you didn't wait and accumulate a lot of these tanks and take them out at the same time? They were cleaned promptly after the test? A. They were cleaned promptly before the test.

Q. So that the dates of the tests would indicate approximately when the tanks were cleaned? A. That is right. They were cleaned immediately before the test.

Q. Was this pickling tank being used in the regular commercial pickling operations during all that period? A. Yes, I suppose it was.

Mr. Lyon: I don't think the witness said that that was a pickling tank, Your Honor. I think that is being injected. I think he should be asked—

Mr. Owen (interposing): What was it? A. A bath of boiling sulphuric acid.

Q. What did they use it for? A. For cleaning metal.

Q. What did they do with the metal after it was cleaned? A. After the metal is cleaned then they plate it.

Q. Did you ever run any corrosion tests in one of defendant's commercial truck tanks? A. You mean the large size truck?

Q. The one that they use in delivering acid from the storage stations to the wells for acidizing operations? A. No.

Q. You had plenty of them around there at Duncan, didn't you? A. Well, there are some there, yes.

Q. Some there all the time? A. They are being made, shipped out all the time.

Q. But you never ran any test in one of those tanks? A. No, I haven't.

Q. The tanks when they are made by this Duncan Tank & Welding Company, they are delivered then to the Halliburton Company at its plant in Duncan, is that right? A. Yes.

Q. And then the Halliburton Company puts in these lead plates? A. Yes.

Q. And does the Halliburton Company also give what is called a polarizing treatment to the tanks before they leave Duncan? A. Most of them are before they leave Duncan.

Q. So that you have there in Duncan these tanks which the company uses in delivering acid from the storage stations to oil wells, both before they have been equipped with these lead plates and after they have been equipped with them, and after they have been polarized? A. Yes.

Q. As I understand it, the only tests that you made were on these cylindrical tanks which you have produced, or others made in accordance with them? A. Yes, sir.

Q. In some of these tests you stated that you added copper, lead and iron? A. Yes.

Q. Do you know in what form those metals were added? A. In the form of chlorides.

Q. Did you make the additions yourself? A. Yes, sir.

Q. You had the materials furnished to you by whom? A. They were in stock there in the laboratory.

Q. You weighed them out, the amounts that were to be put in these different acid baths? A. I did not weigh them. I made the calculations.

Q. What do you mean by that? A. I made the cal-

culations of how much weight was to be used, and one of my assistants weighed it out.

Q. Who put them in? A. As I recall it, I put in part of them, and part of them were put in by my assistants.

Q. Did you analyze the solutions either before or after you made these metallic additions? A. Not for the copper and lead; I just analyzed them for iron.

Q. Did you analyze them for any purpose? A. I just analyzed them for iron. We took a sample after we made up our solution, for our initial iron content.

Q. That was the only analysis that you made? A. That is right.

Q. You would take samples of the acid out from time to time and analyze them for iron? A. That is right, yes, sir.

Q. When you removed these lead plates by cutting them off and suspending them from another standard, as indicated in curves 4, 5 and 6 of Exhibit 280, who did that work, and where was it done?

Mr. Lyon: I don't think that is what he said he did, Mr. Owen.

Q. Then he can tell us what he did. A. The lead plates were not removed from the solution. They were just cut with a pair of tin snips, and the stand—the clamp on the stand was clamped to the lead plate, and the lead plate was left suspended in the solution all the time.

Q. And submerged to the same extent that it had been before? A. That is right.

Q. Who did that work of disconnecting the lead plate and resuspending it? A. Well, I did part of it, and of course I would have to have an assistant there to help me. There was generally two of us that cut the lead plate and clamped it.

Q. How did you cut it? A. With a pair of snips, tin snips.

Q. And how long did that operation take? A. Well, I would say about a minute; all you would have to do was to cut your lead plate.

Q. It wouldn't take any great length of time? A. No, it wouldn't take any great length of time.

Q. Now, referring to Exhibit 280, the first run indicated on that exhibit is the No. 5, is it not? A. You mean first in date? That is right.

Q. And the No. 6 run is the second in date? A. Yes.

Q. And the No. 3 run is the third in date? A. Yes.

Q. The No. 1 run is fourth? A. Yes.

Q. The No. 4 run is fifth? A. Yes.

Q. And the No. 2 run is sixth? A. Yes.

Q. Now turn to the next exhibit, 281. On that exhibit the No. 1 run was the first one, the earliest in date, was it not? A. Yes.

Q. And then the next one to be run was No. 4 on the exhibit, the next one is No. 2 on the exhibit, the next one is No. 5 on the exhibit, and the next one is No. 3 on the exhibit? A. Yes.

Q. Now turn to Exhibit 282. The first run on the exhibit is the earliest in date? A. Yes.

Q. And the fourth one on the exhibit is the next in date, the fifth one is the third in date, the second is the fourth in date, and the third is the fifth in date? A. Yes.

Q. Now, on Exhibit 283, the third one on the exhibit is the first in date, the first one on the exhibit is the second in date, the sixth one on the exhibit is the third in date, the fourth one is the fourth in date, the last one is the fifth in date, the fifth one is the sixth in date, and the second one is the seventh in date? A. Yes.

Q. Now, on Exhibit 284, the fourth run on the exhibit is the first in date, the fifth on the exhibit is the second in date, the second on the exhibit is the third in date, the third on the exhibit is the fourth in date, the first on the exhibit is fifth in date, the seventh is the sixth in date, the sixth is the seventh in date, and the eighth is the eighth in date? A. Yes.

Q. Now, these tests shown on Exhibit 285 used the same tank as that used in the tests shown on Exhibit 280? A. Yes; that is the first sheet.

Q. And there were six runs with that tank indicated on Exhibit 280? A. Yes.

Q. So the seventh run in that tank is the fifth one on Exhibit 285; is that right? A. The seventh run in which?

Q. In that tank. You see, there were six runs in that tank before these runs indicated on Exhibit 285 were run, and I want to get the order in which all of the runs were made in that tank. So we will refer to the earliest of the runs on Exhibit 285 as the seventh run in that tank? A. Well, it is the seventh run on this chart. However, there may be some of those others that I said I couldn't distinguish which tank they were in, in this tank.

Q. I want them in the order on this chart. A. On this chart.

Q. Yes. So that the fifth run indicated on Exhibit 285 was the seventh of the runs in that same tank? A. Yes.

Q. That is, of those that are shown on any of these charts? A. Yes.

Q. And the eighth run in that tank is the third run on this exhibit, the ninth run in the tank is the first one on this exhibit, the tenth run in the tank is the fourth on this exhibit, the eleventh run in the tank is the second on this exhibit, and the twelfth run in the tank is the sixth on this exhibit? A. Yes.

Q. Now, turning to the next exhibit, 286, was that tank used before on any of these other exhibits? A. Yes, it was used on sheet No. 4, the same tank as used on sheet No. 4. That is DX-283.

Q. DX-283, sheet No. 4; there were seven runs, that is right, isn't it? A. Yes.

Q. So that the eighth run in that tank would be the third run on Exhibit 286? A. Yes.

Q. And the second on the exhibit is the ninth in the tank, the fifth on the exhibit is the tenth in the tank, the first on the exhibit is the eleventh in the tank, the fourth on the exhibit is the twelfth in the tank, and the last one on the exhibit is thirteenth in the tank? A. Yes.

Q. Have you ever conducted any other corrosion tests of any kind? A. No.

Q. These are the first and only ones? A. Yes.

Q. Who directed you in the order in which these tests were made? No one? A. No. Mr. Babcock and Mr. Clason and I—

Q. (Interposing): You discussed each test and decided what the next test would be? A. We discussed what the general procedure would be, not as to individual test. What I mean, we didn't have a conference on each run. We would pick out certain groups to run and would run those. We would discuss those, and if there was any additional runs we decided we wanted to make, we would make them.

Q. How much of a group would you run? For instance, the very first test you made, how many did you outline for the first? A. The first test outlined was to run commercial acid on a tank representing our tank in the field, not using a lead plate; and then to run an experiment using the lead plate. That was all we thought at first run. After we ran that, we were curious and ran other experiments. We also agreed to use arsenate trioxide and Tergitol in that first set of runs.

Q. Well, now, will you point on this Exhibit 280 which tests were decided upon at the first conference before any of them were run? A. I probably could tell you better from this data book. We decided to run experiments shown as Curve 5, Sheet 1, and the one shown as Curve 6 on sheet 1. And the one shown as Curve 1 on Sheet 1. And I believe that was all on the first run. I don't know whether I could distinguish exactly which runs were run before we had another meeting.

Q. Well, I call your attention to the fact that the third curve on sheet 1 was run before the first one. A. Well, they are both the same runs. What I mean, they were run in exactly the same way. Both would be covered.

Q. Oh, 1 and 3 were run in the same tank? A. Yes, sir. We decided to run commercial acid in our tank, the commercial acid plus our lead plate, and commercial acid plus Tergitol plus lead plate, and commercial acid plus Tergitol, as I recall, in the first.

Q. Now, will your notebook show what your next plan was after those first runs were made? I suppose you had a consultation again. A. Then we decided to run some experiments using arsenic trioxide and Petro-Wet, and then run experiments where we had our lead plate connected and then disconnected and cleaning the tank after twenty-four hours, and after we had run those, then we decided to make up another hard steel tank, making three hard steel tanks and two soft steel tanks to duplicate the casing in the well, and run all of those using commercial acid and commercial acid plus our lead plate where the tank was cleaned and not cleaned after twenty-four hours. And the commercial acid plus Tergitol, and the commercial acid plus arsenic trioxide.

Q. Now, can you tell about when that conference was had? A. It was shortly before March the 31st, 1941.

Q. Well, then you proceeded to have these other tanks made up, did you? A. Yes.

Q. Then started in another series of tests? A. Yes.

Q. Now, can you point out, without giving the order in which they were made, the tests that were conducted in accordance with the plan laid out at that conference late in March? You have already given the order in which they were run. I just want to know which of these groups were run in accordance with that conference. A. Well, all of them are dated after that time.

Q. Then all of them dated later than March 31 were run in accordance with the plan made at that time? A. Yes—well, except that there are other plans where we used the ingredients of the Zahn well, that was made after we received our answer to the second set of interrogatories.

Q. Which of these groups would that be? A. Well, those were all made after June 10, on or after.

Q. Now, as to the order in which this second set of tests was run—I mean the large group that you ran after the second conference. Did you consult either Mr. Clason or Mr. Babcock as to the order in which those tests were run? A. No.

Q. That was left entirely to your judgment? A. Yes.

Q. Did you know what you were trying to show by those tests? A. We wanted to show what the lead, what kind of protection our lead plate gave, compared with commercial acid without any lead plate.

Q. You knew that you wanted to make a good showing for the lead plate, is that right? A. Sure.

The Court: When it was connected, you mean? A. Yes, sir.

The Court (to Mr. Owen): You meant to include that in your question, the lead plate when it was connected? You meant that, Mr. Owen—you meant to include that in your question?

Mr. Owen: Well, I did not ask that question.

The Court: When you said you wanted to make a good showing for the lead plate, you meant when it was hitched up?

Mr. Owen: Oh, yes, when it was hooked up to the steel tank, that is right. A. Yes.

The Court: In other words, that is their claim that—

Mr. Owen: Oh, yes.

The Court: And when it is disconnected, that is out. That was the way I understood it. Here is one question that occurred to me that I wanted to ask you, witness. In your effort to get the proportion of the steel exposed to the acid, and the amount of lead exposed to the acid, you tried to get that comparable to the steel and the lead of your transportation tank? A. That is right.

The Court: And did you take into account the fact that you, for instance, as to the iron, that you were not going to fill it within—the condition in your tanks too, I suppose, your transportation tanks, are they filled clear to the very tip-top? A. No, they are not.

The Court: And here of course this wasn't filled to the tip-top (indicating), and here is some of the lead, you took that into account, that this part over outside here of course wasn't going to touch it? A. That wasn't included.

The Court: You didn't include that, and the same

way for it a little ways down, for the lead here (indicating), was true of the iron to the lead, that the acid wouldn't reach all of the lead you would use? A. Yes.

The Court: But you took that into account as best you could? A. Yes.

The Court: To make the two comparable, and you have got your figures in there as to that, haven't you? A. I don't know whether I have the figures—

The Court: That is what you tried to do and you have shown us right here, anybody that wants to see it can? A. Yes.

The Court: But you did take that into account, that all of this lead outside of the iron tank— A. It wasn't calculated in, included in the calculation.

The Court: All right.

Mr. Owen: Did you consider putting the lead plate on the bottom of these tanks as it is in the transportation tanks used by the Halliburton Company? A. No, we didn't; we used it this way so we would be able to disconnect the lead plate easily without emptying the acid from the container.

Q. It would have been possible to put the lead plate on the bottom so as to make your tanks more nearly resemble the transportation tanks, wouldn't it? A. Yes, we could have, but when we disconnected the lead plate we would have had to empty the acid and it would have required more time.

Q. Referring to page 121 of DX-277, I find at the bottom of the page this note, "Lead plate was copper-colored at end of run." Can you tell me who made that note, and what it means? A. I made this note, and on this particular run—as you notice, we ran quite a few tests before this, and the motor, like you see here in the courtroom, was beginning to corrode; and after a run had started, we decided that we would provide some means of protecting this motor from the fumes; so we cut a piece of inner tube, and tied it around the motor with copper wire; and after we had stopped the run, and poured the acid out

of the tank, we noticed that the lead plate was copper-colored, very muchly.

Q. Was that copper wire in the acid? A. We do not know. We had already poured the acid out. We don't know whether there was any fragments left in, or not, or whether they had all been dissolved; but since it was the only one with the lead plate that was copper colored, we presumed that there was a chance for error there, that we might have dropped some of this copper wire in there.

Q. Do you know whether the copper wire that you used in tying this rubber around the motor was immersed in the acid, or any portion of it? A. No, it was not, unless it dropped in.

Q. It was up where it would be contacted by the fumes of the acid? A. Yes, sir.

Q. Which run is that on these charts? A. So for that reason we did not plot it on the charts, because we thought there was a chance for error in that.

Q. Where did that come in connection with the runs on the charts? A. It would be on the chart, sheet 2 (DX-281).

Q. In the order of the running of the runs, where would it have come on this chart? A. It would be between runs 2 and 3.

Q. You mean it was made after run 2, and before run 3? A. Oh, you are talking about the time? This test was run May 6, 1941.

Q. What did that run have in it, anything, in the acid? A. It had lead plate and Tergitol.

Q. Had it been plotted on this chart, Exhibit 281, the line would have passed through there? A. Yes, there were 82 ounces per 1000 gallons at the end of 24 hours (indicating).

Q. Is that where I have made this pencil mark, the little circle? A. Yes.

Q. If you will turn to page 130 of that notebook, at the bottom of the sheet there appears this entry: "At 9 o'clock next morning when emptied the tank was copper

coated and the lead plate was white (probably $PbCl_2$)." Did you make that entry? A. No, I didn't. Francis Anderson made it, I believe; it looks like his handwriting.

Q. Do you know any more about it than what appears in the entry? A. No, I don't.

Q. What run is represented by that sheet on the chart? A. That is test "T," a continuation of test "S," which was C. P. acid, which contained iron, lead and copper in the same proportion as that found in the Zahn well, and after 24 hours of test "S" we put a lead plate in the solution and connected it to the tank, which was called "Test 'T'," and after we had left the lead plate there and continued that run, when we removed the lead plate there was some copper coating on the iron tank and the lead plate was white.

Q. Now, will you point out on your chart which one represents Test "S" and which one represents Test "T"? A. I don't have Test "T" on this; I have Test "S" on the chart.

Q. Where would test "T" have come in the order of time on these charts? A. That was run for 13 1/3 hours, and in order to compare it with these, the initial value was already 490 ounces of iron per thousand gallons—in order to compare it with these I will have to substract this last value from the original value.

Q. You mean your solution tested 490 ounces of iron per thousand gallons when test "T" was started? A. Yes.

Q. Then how much did it test when test "T" was concluded? A. 511, which would be a difference of 21 ounces per thousand gallons.

Q. Then where we have mentioned parts per million we should have said ounces per thousand gallons all the way through? A. Yes. At the end of 13½ hours, 21 ounces per thousand gallons.

Q. Is that the right sheet (Sheet 1) where this test would have come in? A. It was a C. P. acid but we have no values with the C. P. acid run with lead plate to compare this with

Q. Well, I asked you to point out on the chart the point where this test would have come in the order of time had you recorded it on the chart. Will you do that? A. Well, in that case it would have been recorded—these are not made according to the time when they were run. They were made according to tank. It would have been either recorded here on PX-280 with the other lead plates and indicated as C. P. acid.

The Court: In other words, you haven't any chart it would go on unless you made a new chart? A. Yes.

Q. Well, will you point out where your test is on these charts? A. This is sheet No. 6. Test S is curve 1 on sheet 6 (DX-285).

Q. Now this test T as I understand, was run in the same tank and immediately following Test S, is that right? A. That is right. When we ran tests the corrosion was at this rate (witness indicating). When we put our lead plate in, connected it, at the end of 13½ hours our lead plate had given this amount of percentage as compared with the C. P. acid without the lead plate. (Witness putting dot on chart.)

Q. When you say this amount of percentage you have indicated? A. The end of 13½ hours the corrosion had increased 21 parts per million.

Q. And that is indicated where I make the pencil mark, circle, or dot on PX-285 (counsel putting dot on chart). A. Yes.

Q. Now, I want to get this perfectly clear. Your test S had what in the acid? A. It was C. P. acid plus iron, lead and copper added in the same proportions as used in the Zahn well.

Q. And then your Test T which followed immediately after Test S used the same acid but added the lead plate? A. Lead plate connected.

Q. And you used the same acid that had been used in Test S? A. That is right.

Q. Without changing the acid. A. Yes. It was cleaned. Yes.

Q. You poured the acid out of the tank and added the lead plate, and then poured the acid back into the tank, same acid? A. That is right.

Q. And the introduction of the lead plate reduced the rate of corrosion from—what is it up here? From about what? A. From about 322 down to about 21 ounces per thousand gallons.

The Court: But this, as I understand it, means it was not all due to the lead plate?

Mr. Owen: That is true.

The Court: That is right, isn't it, because the lead—this other— A. (Interposing): Well, the amount without the lead plate was 322.

The Court: Yes. A. When you added the lead plate, it brought it down to 21.

The Court: But it wasn't raw acid which you put the lead plate in? A. No.

The Court: So I can't give the credit to the lead? A. No, you can't.

The Court: In other words, as I understand it, your acid has brought it down to a point about here where my—

Mr. Lyon (interposing): Oh, no. A. Oh, no. Raw acid.

The Court: Raw acid. Then you put in these other ingredients? A. No; this is the same acid. It ate this much, and then we added the lead plate and it only ate this much (indicating on the exhibit).

The Court: That is the lead plate? A. Yes.

The Court: And this is the acid. These others don't enter into it at all? A. Don't enter into it at all.

The Court: What I said was wrong, as I understand it now. The lead plate, if that experiment was correct and I read the results, would do all the work of bringing it from the raw acid to there.

Mr. Owen: Oh, yes; the lead plate was the only thing added.

The Court: I thought he—I couldn't see why, but I got the erroneous notion that you had put that acid in, let

it work, or put those ingredients in and let it work, and it brought it down to there, and then you cleaned the tank and put those same old ingredients in, what had been used back in there again with the lead plate? A. No.

The Court: I was wrong. A. Yes. It was this acid here (indicating).

Mr. Owen: Now, as I understand you, in your test S which is No. 1 on PX-285, your rate of corrosion at the end of thirteen and a half hours is shown. A. Yes.

Q. At the end of thirteen and a half hours, in test S, your acid had how much iron? A. I believe I said 322 a while ago. But it is 332 ounces per thousand gallons.

Q. Then you continued that run how long? A. Twenty-four hours.

Q. And at the end of twenty-four hours how much iron did the acid have? A. It had 545 ounces of iron per thousand gallons.

Q. Then you poured that acid out, at the conclusion of run S, scrubbed out the tank as you have previously explained, that is by the boiling of it or putting it into this pickling bath, and letting it stay there for an hour in the boiling acid, and then removing and scrubbing it out with a wire brush and rinsing it with hydrochloric acid; is that right? A. That is right.

Q. Then you poured the same acid back into the same tank and put the lead plate in it?

The Court: Now, by the "same" you don't mean this old acid that he used? A. Yes.

The Court: You mean the new acid? A. No, the same acid.

Q. (By Mr. Owen): The same acid. You poured the same acid back?

The Court: As used in the run shown by curve 1? A. Yes. We removed the acid from the tank, cleaned the tank, connected the lead plate and then poured the acid back into the tank.

The Court: All right, now. Not fresh acid? A. No.

Mr. Lyon: Those different runs on these sheets used different acids.

The Court: I don't see how I am going to compare these when you are through, because this acid--this isn't this acid, this isn't this acid the way—when you start on this curve, it isn't the same condition it was in when it started on that curve. A. No.

The Court: All right.

Q. (By Mr. Owen): The acid that has been removed —that has been used in run S, was removed from the tank, the tank then subjected to this cleaning treatment, and the same acid was returned to the same tank; that is right? A. Yes.

Q. And then you added the lead plate to that tank, which acid had been in the test S? A. Yes.

Q. And then you ran it for thirteen and a half hours, and you found how much iron in the acid at the end of that time? A. At the end of that time, the total iron content was 565.5 ounces per thousand gallons.

Q. And then you—you say your added iron in that thirteen and a half hours would have been how much? A. 20.5 ounces per thousand gallons.

Q. So that after it had in all of the iron that was taken up in test S, it ran for thirteen and a half more hours after the cleaning operation and took up how much more iron? You just gave it to me. What was it? A. 20.5 ounces per thousand gallons.

Q. Now, at thirteen and a half hours, at the end of run S, how much iron did the acid eat up? A. 332 ounces per thousand gallons.

Q. That is in the thirteen and a half hours. The last thirteen and a half hours, I want. Of test S? A. May I have my calculation book? (After calculating): In the last 13½ hours of test S, the acid ate 217 ounces per thousand gallons.

Mr. Lyon: I would like to suggest to Your Honor that we don't know unless somebody asks at this point in the record, we won't know when he put the lead plate in whether it was bonded to the steel or not. Sometimes, as I understand it, they have the lead plate in without connect-

ing it to the steel, and sometimes they had them connected to the steel, and the record does not show now whether it was connected to the steel or not.

Mr. Owen: Is that your book? A. Yes.

Mr. Owen: I will ask him.

Mr. Owen: Was that lead plate bonded to the steel in your test T? A. It was.

Q. You didn't try a similar test to see what it would have been had it not been bonded to the steel? A. No, I didn't.

Q. At the end of test S, did you look at the walls of the tank to see whether or not it was coated with copper? A. I do not recall. It is not recorded.

Q. But you did notice at the end of test T, the walls of the tank were coated with copper? A. That is recorded here. I did not notice it myself.

Q. You did not make that note? A. No.

Q. On page 122 of this same notebook, there is an entry at the bottom, "Acid was black with suspended matter at end of this run." Did you write that on there, Mr. Hathorn? A. No, sir, I did not.

Q. Well, who did? A. I could not say.

Q. Have you got any explanation for it? A. No, sir, I have not.

Q. Will you point out on the charts which run that is? A. (Indicating): Here. This is DX-283, sheet No. 4, curve No. 5.

Q. That is the test that appears on page 122 of your notebook? A. Yes, sir.

Q. What was in that acid, anything? A. Commercial acid, plus lead plate.

Q. Anything else? A. With the lead plate removed and tank cleaned at the end of 24 hours. This was in soft steel tank No. 4 (indicating).

Q. Was it continued after the 24 hours? A. Yes, sir. The lead plate was removed, the tank was cleaned, and continued for an additional 24 hours.

Q. And then this note at the bottom of the sheet that

the acid was black with suspended matter at the end of this run refers to the end of 24 hours, or the end of the extended run? A. I would presume that it was at the end of 24 hours, because it is written under the—at the end of the first 24 hours.

Q. When the run was continued, was it continued with the same acid? A. Yes, sir.

Q. Have you any idea what that black suspended matter was? A. No, sir.

Q. Now, on page 127 of this same notebook there is a note, "No stirring since 8 8 8." Will you explain what that means? A. This is in plain commercial hydrochloric acid, with no lead plate, in hard steel tank No. 1; and after 24 hours we shut the motor off and allowed the acid to remain in the tank without being stirred from 1:30 P.M. to 9 A. M.

Q. Which run is that, and which chart? A. This is not in the chart. There was no agitation. We do not have any on the charts without any agitation.

Q. In the test reported on page 129 of this same notebook, the statement is made that iron, lead and copper were added to one crock. What were those crocks? A. Well, they were five-gallon crocks. Just ordinary five-gallon crocks used to mix acid in.

Q. Do you know how much copper, lead and iron was added to that acid in the test on page 129? A. The same amount as used in the Zahn well.

Q. The amounts are not indicated on this page, are they? A. No.

Q. Where are they indicated? A. I have the calculations. I believe they are indicated in the other book, the data book. There were added 380 parts per million of iron, 435 parts per million of lead, 3.1 parts per million of copper, this is by weight.

Q. Now, how do you connect that entry up with the entry on page 129 of the other notebook?

The Court: You mean how does he identify? A. The letter "S" is the same.

Mr. Owen: Now, I believe you stated that you did not weigh out these metal additions? A. No, I did not.

Q. Did you check the weights in any way? A. No, I didn't.

Q. You don't actually know how much copper, lead and iron went into these tanks? A. Yes, if their weights were accurate, and I trust them.

Q. You mean that you simply told them to put in so much and you relied on them to do it, is that it? A. Yes; I relied on them to make the weights.

Q. There is no entry in any of these notebooks, is there, showing the weights that actually were added to the different tests? A. Yes, on page 50 of DX-278.

Q. What does that show? A. Iron chloride was 85.7 grams, lead chloride 27.1 grams, copper chloride .387 grams.

Q. And that is what metals were added to test "S," is that right? A. In tanks Nos. 1, 2 and 3, and in soft steel tank No. 4—I mean iron chloride 88.5 grams, lead chloride 28 grams, copper chloride .398 grams.

Q. And you have only one indication of weights for tanks 1, 2 and 3, that is right, isn't it? A. Yes.

Q. You assume that those exact amounts were placed in each of those tanks? A. Yes.

Q. Now, when you cleaned these tanks after a run, how did you suspend them in the sulphuric acid pickling tank? A. They were suspended by clamping them to an electrical bus bar running over the sulphuric acid bath which was connected to electric current for making them the anode in the tank.

Q. What metal was that bar made of? A. I suppose it was made of copper, most bus bars are.

Q. Will you explain just how the tank was clamped to that copper bar? A. By a steel hook. A steel hook was hooked to the handle of the tank and then hooked onto the copper bus bar, allowing the tank to be suspended in the acid.

Q. How high above the top of the acid is this bus bar? A. It would be a guess. I would say about six or eight inches at least.

Q. Did it run across the pickling tank parallel with the surface of the solution? A. Yes.

Q. About six or eight inches above? A. I wouldn't say exactly six or eight inches but close to that.

Q. How far was the top of your tank from that bus bar when you hooked it onto the bus bar as you have explained? A. It was completely immersed in the solution. I would say it was at least 10 or 12 inches below the bus bar.

Q. I believe you stated what this pickling tank was used for. I haven't it in mind. Will you repeat that? A. I don't know whether you would call it a pickling tank or not, but it was used to clean the metals. We have our own plating shop. We do a lot of plating of our equipment. It is used to clean the metal surface in order to plate the iron, steel.

Q. Do you know what acid is used in that pickling tank? A. Sulphuric acid.

Q. Do you know whether any pickle control substance or acid regulator is used in that pickling tank? A. I understand there isn't.

Q. Just the straight acid, so far as you know? A. Yes.

Q. Did you ever test that acid during the time that you were cleaning tanks in it? A. No. However, since the tank was made the anode all the corrosion should have been on the tank. If there was any impurities on the tank it should have been removed since it was made the anode. This test tank was made the anode in the sulphuric acid solution so that any deposit that had been formed on the test tank would be removed electrically. That is reversing the procedure in which the tank had been coated; in our test it would be removed in exactly the opposite way.

Q. And that would remove any lead that might be on the surface, you think, of your tank? A. I would think so.

Q. How about copper? If there was any copper on the surface would that remove the copper? A. Well, if the copper was able to plate on in our test it certainly will be able to be removed in the cleaning tank.

Q. Now, did you make any test or analysis to ascertain whether or not the lead and copper were actually removed from the surfaces of your tanks by your cleaning operation? A. No, I think not.

Q. Do you know how frequently that acid was renewed in the pickling tank? A. No, I do not.

Q. Do you know whether it was ever changed? A. No, I do not.

Q. Do you know the conditions of these parts when they were placed in this pickling tank for removing the scale or whatever was removed? That is, were they dirty, had they been pickled before, how had they been handled and used? A. These tanks?

Q. No. The metal pieces which are placed in the pickling tank for the cleaning operations preparatory to cleaning. A. Most of the parts are just parts that have been machined in the shop, are taken directly from the machine shop to the plating shop.

Q. So that when they are placed in the pickling bath they are covered with oil, dirt and grease that comes from the machine shop? A. In some cases they may have some oil.

Q. After your tests that were indicated on these charts, did you analyze any of the solutions for lead, copper or other content than iron? A. No.

Q. When your tanks were put into this pickling tank, did they have the lead plates connected to them? A. You mean in the sulphuric acid?

Q. Yes. A. No.

Q. Did they have any portion of the lead plate connected to them? A. They had just a section where the lead was puddled onto the tank.

Q. That is where you sawed off the main section of the lead, the remaining part was on the bank, when you put it into the pickling solution? A. Yes, sir.

Q. And that was true in each case where the lead plate was used? A. Yes, sir.

Q. Before you used these tanks which you have de-

scribed, did you put them through any polarizing operation? A. No, sir.

Q. Do you know about a polarizing operation to which your regular transportation tanks are subjected? A. Yes, sir.

Q. But you did not do that to these? A. No.

Q. What if any check did you make on the acid that you used; did you check each carboy or each shipment, or what? A. The only check we made was when we made up our batch for the test, we made—that is, we took a sample before we put it in the tank, and analyzed it for iron content.

Q. That is the only analysis that you made? A. Yes.

Q. Will you explain just how you made the iron analyses? A. It is given in front of the calculation book, DX-279, on page 27. This is the procedure; I will read it. (Reading): "Bring to boil 10 m. l. of the acid solution; while hot, reduce ferric iron to ferrous iron with stannous chloride (using two drops excess). Dilute to 150 m. l., add 25 m. l. saturated mercuric chloride, 20 m. l. titrating fluid, 10 drops barium diphenylamine sulfonate indicator; titrate to purple end point with potassium dichromate."

Q. The dichromate solution. How much of that did you use? A. Well, you will have to refer to the—each one will be different for each titration. They are given in the data book.

Q. Will you look through that book and see if it is not true that in giving some you used less than one cubic centimeter of this titrating solution? A. I beg your pardon. If I am not mistaken, there was a factor on this titration fluid of 10.

Q. What do you mean by that? A. Where they have .0420 c.c. it was .420 used.

Q. Well, you say if you are not mistaken. Is there anything in this book to indicate that? A. I believe not.

Dr. Prutton: .420 is less than 1. A. Yes.

Mr. Owen: Well, now, in answering that question, you were referring to page 35 of DX-277? A. Yes.

Q. Now, will you explain the entries in the fourth column of the table on that page and state what you understand them to mean? Do they show the quantity of this titrating solution that was used in these different tests, or in these different analyses? A. Yes, I would say they did.

Q. And what are those? Read a few of those figures down, will you, from the top? A. Now, as I said before, there is a factor of 10.

Q. Yes. You read them and then I will bring that out. A. .0420, which would be .420 c.c. of titration fluid used.

Q. That would be your factor of 10? A. Yes. That is before the test started. That is the titration we got on the blank sample.

Q. Now, how much in ounces or in teaspoons would that .042 be? A. I think you will have to have some of the doctors figure that out. I don't know. I am not a chemist. The boys who made these titrations were chemists, all of them, and they made these entries.

ALFRED DOUTY,

a witness called on behalf of defendant, testified as follows:

DIRECT EXAMINATION

I am 42 years of age, reside at Elkins Park, a suburb of Philadelphia, Pennsylvania, and am the chief chemist of the American Chemical Paint Company of Ambler, Pennsylvania. As to my training in chemistry, I attended the University of Pennsylvania and studied chemical engineering. At the conclusion of the course I got a bachelor of science degree.

Mr. Lyon: What if any experience did you have in practicing your profession from the time you left school up to the time you became connected with your present company? A. From the autumn of 1919, the year when I graduated, until the summer of 1923, I was employed by a Philadelphia consulting engineering firm, Julian S. Simpson. The firm was engaged in general power plant consulting practice, including the study and treatment of boiler water for the prevention of scale, and also engineering problems connected with the efficiency and design of power plants. In 1923, in the summer, I became connected with the American Chemical Paint Company, at which time the main problem under investigation in the laboratory was the development of materials which were to conserve acid in the pickling of steel. I worked intensively on the inhibiting phase of the business up until about 1930. I also did work on many other products, including paints, cleaners for metal surfaces, soldering fluxes, and so forth. In 1930 I was given charge of the patent department of the company, in addition to my duties as chief chemist, and that meant that I was unable to spend as much time in the laboratory as I previously had, but since that time I have been directly in charge of the laboratory and we have had no less than one man at any time giving his full attention to the develop-

ment and study of inhibitors. Other men have been in charge of problems involving corrosion and its prevention generally.

I first started work with the American Chemical Paint Company in 1923 and have been with them ever since. I knew James H. Gravell of Elkins Park, Pennsylvania, named as the patentee in letters patent No. 1,678,775, granted July 31, 1928, which is DX-5 in this case. I knew Mr. Gravell very well. He was president and founder of the Americal Chemical Paint Company, and he was, at first, the only chemical expert the company had. As a matter of fact, I was the first chemist employed by the American Chemical Paint Company. Mr. Gravell at that time spent at least half of his time in the laboratory. He was a very brilliant man, although his formal training was not very great. And I worked beside Mr. Gravell a number of years. Of course, he had the duties of running the whole company, and he couldn't work continuously in the laboratory, whereas I did. It was not long after I had become connected with the company that we began to hire other men. But at first I worked with Mr. Gravell alone exclusively. Mr. Gravell died in December, 1939.

Q. You have said he was a very brilliant man. But I think the court would probably like to know a little more about him. It is a fact that he started this company with nothing but an idea, and what did he have that he made out of it when he died, just in a rough way, give the court an idea. A. I don't know whether it is pertinent to the issue, but in order to make clear what Mr. Gravell did, he started as an electrical engineer and he worked for the Hale & Kilburn Company in Philadelphia, who were making the early steel bodies, automobile bodies, and the early steel automobile bodies were rusting so badly under the paint that Hale & Kilburn were taking them back faster than they went out. And Gravell, in connection with a Philadelphia druggist by the name of George Feidt, conceived of an invention whereby they treated these bodies with a mixture of alcohol and phosphoric acid, which removed the

things from the surface which caused them to rust underneath the paint. And then he had—of course, he had the idea, and Gravell used to mix the things up in the morning to go out and sell them in the afternoon and they—it just happened to fill a great need, and so the company began to prosper.

Mr. Owen: How do you know all this, Mr. Douty? A. Well, I knew Mr. Gravell very intimately for about twenty years. I knew him and a great many of his friends. I have seen a good many of his records. He was a great expert on electric welding. He was an expert in the case on the Harmatta patent between Thompson Electric Welding Company and Ford Motor Company. I still have his file on that particular matter, which involves about ten large drawers of filing cards, and a number of larger drawers of data. I don't know that I know anything in life better than I know Gravell's accomplishments and mentality.

Mr. Lyon: Now, you had not finished your answer to my question. I asked you a question, that is, you told what he started with; can you give us an idea of how well he got along, and how he finished? A. Mr. Gravell will probably be best remembered by the public because, at his death, he left the entire company, which is valued at some millions, to a number of his employees, of which I am one. His company was extremely prosperous during his lifetime, and he died a very—well, I would say a moderately wealthy man at any rate. He did not leave any family. His wife had died just a year before he died, and he had no children. He had one brother.

Q. Now, when you went to work with the company in 1923, was the company interested in pickling agents, or inhibitors in any way? A. Yes, sir, it was.

Q. What was it doing that involved the use of inhibitors in acid at the time that you went to work with them? A. When I went with Mr. Gravell, he thought that he—he had been investigating agents that he had heard of that were being sold in Europe, which were said to reduce the attack of acid on steel during pickling, and to save

money; and he had investigated a number of agents, of which he had come across one which seemed to him to have promise. He felt that his training in chemistry was inadequate, and he hired me, because he felt that he needed someone of more training, to investigate systematically the field of inhibitors. And that was my first work. And I, although it was new to me, was able fairly shortly to develop techniques for preparing inhibitors, which went beyond anything that Mr. Gravell had thought of at the time; and it was not long after I got with the company that he began to exploit a material which was known as rodine, and rodine has ever since been the generic term for the kind of inhibiting agents which we sell to the trade for various purposes.

Q. You heard the depositions read here concerning the use of an inhibitor by the Gypsy pursuant to Dr. Westcott's deposition. A statement was made by several witnesses the inhibitor used there was rodine purchased from the American Chemical Paint Company along about 1928, '29 and '30. Were you selling such a material under that name at that time? A. Yes, sir.

Q. Do you know what it was? A. Yes, I do.

Q. Was it an inhibitor for hydrochloric acid? A. Yes.

Q. What was its chemical composition, if you know? A. It was a hydrochloric acid solution of basic materials extracted from a waste product known as bone tar oil or known to the chemists as Dippel's oil. That product was obtained by the distilling of bones—in fact, it consisted of a number of bases wherever protein material is distilled in the presence of fat. In fact, in the presence of the aldehyde acrolein. The basic materials are extracted from the tar oil by mixing them with hydrochloric acid. It then separates an upper layer of oil which is worthless and consists largely of nitriles of higher fatty acids and also a certain amount of tarry material, and there remains a clear hydrochloric acid solution which is the material that is sold as Rodine, or was originally sold as Rodine No. 2.

Q. You have read Dr. Westcott's report, which is in

evidence in this case, have you not? A. I have heard it read.

Q. And you heard what Dr. Westcott had to say in that report as to what Rodine No. 2 would do in protecting well pipe when the acid was being introduced down into the well? A. Yes, sir.

Q. Is it a fact that Rodine No. 2 would produce the result which Dr. Westcott stated in his report it would produce? A. Certainly.

Q. Now, were you aware of the making of the discovery or invention which is set forth in the patent involved in the defendant's counter-claim here, Gravell Patent 1,678,775? A. Yes, I was.

Q. You were aware of Mr. Gravell's work at the time he made that discovery and know under what circumstances it was made? A. Yes.

Q. Before I ask you to give us that history, would you take and refer to the patent itself and tell us what you understand the invention to be, covered by that patent? A. Before I can state what I consider the invention to be, I would have to give you a very brief outline of the state of the knowledge at the time Gravell made this invention, so that the terms he uses, the materials he refers to, may make some sense.

Mr. Lyon: All right.

(Witness continuing): Up to the time of Gravell, there had been a number of patents and references in the literature to substances capable of reducing the rate at which acids attack metal. The only use that had ever been made of that information, as far as I have been able to determine, was in the addition, usually, of organic substances, to the pickling baths in which scale is removed from steel, to reduce the unnecessary loss of metal. Now, scale is removed from steel—scale, by the way, is generally—I mean the oxide which is formed when steel is heated during the fabrication process prior to rolling or forging.

Now, in pickling off that scale the common agent in this country is sulphuric acid. Hydrochloric acid is used

more commonly in Europe. But, sometimes hydrochloric acid is used here. Mill scale is very resistant either to hydrochloric acid or to sulphuric acid, but it is more resistant to sulphuric acid, and the scale is not removed from the steel by being dissolved therefrom; it is removed because it is full of cracks, the acid gets down through the cracks and eats the metal out from under it, and as the metal is eating out from under it hydrogen is generated and the hydrogen gas gets in behind the scale and the scale appears to be either slid off or blown off in flakes when it sinks to the bottom of the bath.

Now, in that operation it is inevitable that some metal be dissolved. The removal of scale from steel is practically impossible to accomplish without the removal of some metal. However, scale is not generally uniform on a piece of steel; it is heavy in some spots and not so heavy in others, or it is more cracked in some spots and not so much cracked in other spots. Therefore, if you have a large piece of steel and are pickling it, the scale may be all off of one end while it is still quite firmly attached on the other, and it is necessary to protect the sound metal, which has been pickled, during the rest of the necessary period until you get the scale all off of the end on which the scale remains.

Well, with that as a preamble, and getting a sort of the state of the art at the time Gravell got into the picture with his patent. Gravell made the interesting discovery that the substance, arsenic, which had been previously mentioned as a restrainer, when used in connection with organic inhibiting materials, really organic inhibiting materials, gave a degree of protection to the metal which had not heretofore even been dreamed was possible. In other words, a degree of protection such that an iron nail, ordinary steel nail, could be put into a ten per cent sulphuric acid solution containing, let us say, a good organic inhibitor such as this solution of organic bases, plus some arsenic, and left there for months and months and months at a time without being apparently affected at all.

Now, arsenic had some great disadvantages in the

pickling of steel. Its use as an inhibitor was originally suggested by a fellow named Meurice, back in the 1880's. Meurice had a wire mill in Belgium, he was the manager; and he found that the wire seemed to be smoother and less corroded when he put arsenic in the acid than when he did not. This he discovered accidentally, because he found that he had two kinds of sulphuric acid from two different sources, and one of them seemed to give him a smoother wire, less breakage in his drawing operation, and certain other advantages over the other one; and he finally traced that down to the fact that the acid had arsenic in it, or considerably more arsenic than the other one. However, sheet mills had never been able to use arsenic. In fact, the use of arsenic as an inhibitor was patented in this country back in 1908. I think that that patent will ultimately be mentioned. Burgess in 1905, at the University of Wisconsin, investigated the effect of arsenic rather completely. The only thing was that nobody was able to make any use of this knowledge.

Arsenic has a curious property, it prevents steel from pickling clean. If the scale is at all rolled into the surface in a peculiar form, and you have arsenic in the bath, the scale won't come out; so that when you go to de-form your steel for your next operation, it has acid spots, and you get trouble either in the finish obtained, or you get trouble with the equipment with which the steel is processed. So that nobody made any use of arsenic. That has been known for a good many years, but nobody had used it.

When Mr. Gravell found out that arsenic, together with these inhibitors, had such a tremendously powerful restraining effect, and almost stopping effect, he felt that that solved a problem that had been bothering our company for a long time. We were shipping organic liquid, I mean, acid liquids, notably this product I have spoken about, which contained water, and phosphorous acid and alcohol, first, in wooden barrels, and since we had trouble with this liquid, we shipped it in rubber lined barrels of our own design, and our own manufacture. Now, those were expensive barrels.

they would only stand up for a few trips, and I have forgotten how much they cost us apiece, but I think it was well over $8. When Gravell found out that arsenic in an organic substance as a restrainer, an inhibitor, had this powerful effect, he immediately saw that this was an answer to the problem of shipping acid or other liquids in steel containers, and he tried it out and it worked very well. And we shortly thereafter started the shipping of some acid liquids in steel drums. Now, our inhibiting agents sometimes had arsenic added to them, that is to say, our rodines. But in small quantities, so that by the time they reached the customer we hoped that all the arsenic would be gone.

Mr. Lyon: This is before Gravell's invention you are speaking of now? A. No, I don't think it is. We had never used arsenic as an inhibitor, because before that time we had known of its disadvantages. But Gravell, when we —our inhibitors were acid liquids also and contained large quantities of inhibitor, but still we shipped them at first in glass. And by adding a certain amount of arsenic to those materials we felt that they would be safe to ship in steel. In any case, the net result was that shortly after this discovery we shipped many, many thousands of drums, steel drums of quite acid liquids all over the country, without having—without having had any appreciable trouble.

Q. Now, before Gravell's discovery, which is—upon which this counter-claim patent is based, to your knowledge had corrosive acids ever been shipped in steel containers? A. No. Not truly corrosive acids. That is to say, concentrated sulphuric acid has been shipped in steel containers, but that is not corrosive to steel appreciably when the concentration exceeds, oh, about ninety per cent.

Q. How about hydrochloric acid? A. I have never heard of hydrochloric acid being shipped in steel, and I don't believe it ever was, before that time.

Q. Before the discovery on which this counter-claim patent is based? A. Yes, sir.

Q. That is, all hydrochloric acid had been shipped in what kind of containers? A. Usually glass carboys.

Q. Mr. Douty, you were explaining the counter-claim patent and its relation to the art. I don't believe you finished when we adjourned. So will you continue? A. Well to summarize, what I said before on this subject, I think that the principal contribution of this patent is this: That although arsenic had been known to reduce the attack of acid on steel any reasonable amounts of arsenic were deleterious in pickling processes generally, and therefore arsenic had never come in use as an addition agent in pickling baths.

Secondly, Gravell was the first to discover that organic materials which had restraining power on the action of acids on the metals co-acted with arsenic and certain other metals to give a very much more powerful inhibiting effect. Although the term "inhibiting" had occurred in the prior art, I don't think it had ever occurred to anyone else that inhibiting in the sense of practically completely stopping corrosive action and could be accomplished by the use of these agents. I think, therefore, that the principal point of this patent is this—that nobody had ever conceived it possible so completely to reduce the attack of acid on steel as to make it safe or practical to carry acid solutions in steel containers. Gravell gave definite examples of combinations which would be suitable for that purpose.

Q. Well, I understand from the testimony, Mr. Douty, that for some period of time the plaintiff employed arsenic as the inhibitor, arsenic trioxide, in accordance with the proportion given in the Grebe-Sanford patent here in suit. Will you tell us whether or not such an inhibitor is a material capable of precipitating a substantial protective coating on steel? A. Unquestionably.

Mr. Owen: We admit that is true—that arsenic does have that property.

The Court: With all these patents, unless it be the—well, I will just talk about the two of them; I am talking about this one here (indicating). I have not analyzed the others to see how they are, but our No. 1 patent and this one run crosswise. One covers transportation for one purpose, and the other for another purpose.

Mr. Lyon: Of course, our position is that our patent very much antedates theirs, and if there is any conflict, the latest patent is the one to fall. Maybe when Your Honor gets through we will both of us lose them, but I don't think you should hold it against the earlier patent, that there is a conflict with a later one.

The Court: Hasn't somebody got a patent for putting an inhibitor in that would take care of all purposes? Didn't anybody get a patent to that effect? A. Not as far as I know, Your Honor, and I have been over it very carefully.

Mr. Lyon: The fellow who invented inhibitors would probably have objected to all of these patents on the ground that under the law he had all of the benefits of his discovery, and if it was good in tanks, he was entitled to that, and if they were good somewhere else, he was entitled to it.

Mr. Lyon: Mr. Douty, suppose you tell us what your views are as to the comparison of Gravell's invention, with what the plaintiff does when it is transporting the acid down their pipe in the well? A. Well, to follow along the argument that Your Honor has just put forth, it seems to me that if there was a patent with a method of preventing an acid solution from attacking a steel transportation or storage drum, and I think one can say this is a container made out of steel, that is, a pipe line is a container made out of steel, as I conceive it, the plaintiff does not claim it has any function in going down this pipe line whatsoever; the Grebe and Sanford patent, as I understand it, is a method, and is written on a method of getting that to certain formations, that acid, and you cannot treat it until your acid gets into the formation, and the only way you have got of transporting it down there is to put it through the steel pipe. I cannot see that the steel pipe of the plaintiff, or of the defendant, is any different than the storage or transportation container of Gravell. They are both made out of steel, and the problem in both cases is to keep the acid from eating, and Gravell found a pretty good way of doing it.

Q. You referred to Gravell as including containers. I call your attention to the eighth line, the second word in

the eighth line on the first page of this Gravell patent, where he says, "Steel drums or containers." Now, is the problem of protecting steel transportation drums, or containers from the corrosive action of hydrochloric acid by inhibitor any different in the case of a tank or drum on a railroad car, or on an automobile truck, than it is in a well pipe, going down a well? A. No, only the one, of protecting the steel drum on a truck is a little more difficult problem. The drum on a truck is supposed to keep the acid in it for hours, days and weeks. The pipe has acid in it for a few hours at most.

Q. Now, just to make one point clear, does it make any difference as to protecting the transportation tank or container whether it be on a truck or on a railroad car, or a pipe down a well, what happens after the acid leaves the pipe or container, what you do with the acid or what you are using the acid for after it leaves the tank or the pipe? A. As long as the purposes for which you are going to use the acid are not in any way interfered with by the substance you put in it, it doesn't make any difference how you transport it to the spot where you are going to use it, obviously.

Q. There can't be any argument, is there, but what while the acid is going down the well pipe the pipe is a container for the acid? A. No.

Q. Now, I believe you have testified, have you not, as to the circumstances under which this discovery or invention covered by the Gravell counter-claim patent was made by Mr. Gravell? A. Yes.

Q. Were those facts given from your own personal knowledge? A. Yes, such facts as I have given are from my own personal knowledge.

Q. Can you fix the date, or a date prior to the filing of the application for this Gravell patent, on December 11th, 1925, at which time Mr. Gravell was—had made this discovery, of your own knowledge, and can you produce any original record from your company showing and referring to that discovery? A. I have the original record book and I will produce it. (Producing book.)

Q. What can you state as to the date this record was made in view of the date appearing on the record, October 29, 1924? A. I know that this material had been reduced to a commercially feasible product and had actually been tested in practice at some time before that date.

Q. Did you see this record on or about October 29, 1924? A. As a matter of fact I believe I got this formula up. Although Mr. Gravell's name appears on it as approving it, I actually got up the formula.

Q. Under his direction? A. Yes.

Q. Now, were there any further formulas for this patent following this date of October, 1924, and up to the date of the application for the counter-claim patent, which was filed on December 11, 1925? A. Yes, there were a number of them.

Q. Have you any more formulas for this same invention of the counter-claim patent in this record prior to December, 1925? A. Yes, I have. I want to point out that that particular embodiment of the invention described at the top of page 2 on the left hand column is by no means the only embodiment. That particular material is, in itself, meant to be transported in steel and then to be useful as an inhibitor to be added to pickling baths or for any other inhibiting purpose.

The Court (interposing): The real purpose of this was to fix it so you could transport it? A. Yes, sir.

Q. As I understand your testimony, these formulas were not entered in this formula sheet until they were completed experimentally and actually placed on sale, is that correct? A. That is correct.

Q. As standard products of your company, or regular products of your company? A. Yes.

Q. Now, have you any further records showing formulas under the counter-claim patent prior to December, 1925? A. I have a formula here which coincides very closely with the formula given at the head of the second column of page 2 of the Gravell patent. This is the material known as Rodine No. 4, our formula No. 103, dated March 14, 1925.

Q. Will you compare that with the corresponding formula in the patent? A. This formula is essentially identical with the formula in the patent. I do not see any significant difference. There are more things in our formula book than appear in the formula in the patent, but the end result is exactly what is given by the formula at the top of page 2.

Q. Mr. Douty, did your company ever practice the shipping of any of these products in steel containers? A. Yes.

Q. Can you state when that practice commenced? A. I can't give you an exact date and there is nothing in these formula sheets that tells me the exact date, but I do know that the purpose of putting the arsenic in every one of these formulas was so they could be shipped in steel containers. There wasn't any other purpose in putting the arsenic in. So I am quite sure shipment of these materials in steel containers began certainly somewhere in the neighborhood in the time corresponding to the dates on the formulas, or before.

Q. Well, as a matter of your own independent recollection, can you remember that there were such shipments? A. Yes, I can. But I can't fix the date any better than by referring to the sheets.

Q. Now, just tell us what your company shipped in steel containers, beginning as near as you can with the dates that you have indicated. A. It certainly shipped the products to which I have already referred in steel containers, with the possible exception of the Scaline, because I don't know of my own knowledge that that was ever shipped in steel; the others I do know were shipped in steel. When the others began, I can't say. In addition to the products I have already mentioned, both arsenic and inhibitors of the type mentioned in the Gravell patent were likewise customarily added to certain of our other products, so that those other products could be shipped in steel containers, to my knowledge.

Q. Then, based on your recollection and based on what

assistance you get from this record, about what period, as near as you can fix it, did this shipping in steel containers start? I am not asking for an exact date but a safe date. A. A safe date would be somewhere in the last third of 1924.

Q. And after you once established that practice, to what extent did you continue it? The practice of shipping in steel containers? A. The practice continues to the present day. All acid liquids which are not otherwise deleteriously affected by the presence of materials like arsenic and our inhibitor of the Rodine type, of the early Rodine type, are still so shipped. And that means a great deal of liquid is so shipped.

Q. Can you give the court a picture of how much business you have been doing since 1924 with these materials containing these agents in steel containers, what industries they were shipped to, what the materials were, and some idea who the customers were. A. Well, materials of the type described in the first two formulas which I gave, have been shipped very extensively to the steel industry for use in the pickling of steel over a long period of time. Now, I can't give you a definite idea of how much business that was except that I know that it amounted to an average of possibly some hundreds of drums of that particular compound per year. In addition to that, there have been many more hundreds of drums of our body cleaner Dioxidine shipped in steel by the aid of additions of arsenic and other organic material of an inhibiting nature.

Q. What were you shipping that Dioxidine in to the automobile or paint industry prior to Mr. Gravell's invention set forth in the counts in patent? A. At first in glass, then in wooden barrels, and then when those wooden barrels leaked too badly Mr. Gravell developed a new type of rubber lined barrel, on which he had a patent.

Q. To what extent did this counter-claim invention of shipping in the steel containers replace those other forms of containers? A. It replaced them altogether. I must modify that statement—to the extent that we still supply

the Oxidine to such retail customers as can only buy a gallon, in gallon bottles, but other than that we ship quantities from 10 gallons upward in steel.

Q. Did you give, or can you give any estimate of the value of the products that have been shipped under this counter-claim patent by your company in steel containers, just as a round figure? A. Well, it would be pretty much of a guess.

Q. Well, make a conservative estimate. A. Well, it would be something over two million dollars, and something under ten million dollars worth, but I cannot tell you exactly.

Mr. Owen: You mean that you shipped in steel containers? A. Yes, products of that value.

Q. Can you give us the names of a few of the representative customers that such shipments have been made to? A. Oh, yes. Hudson Motor Car Company, Packard Motor Car Company. Shipments were made to the Studebaker Company, the Ford Motor Company, Chrysler Motor Company. United States Steel Corporation, to its various plants all over the country, including the Carnegie-Illinois Steel Company, and various other branches. I would say practically to every, pretty near every representative motor or steel company—I would say that they have at some time or another received products shipped in steel, the steel containing materials in accordance with this patent.

Q. You have covered the steel industry and the automobile industry. What about the oil industry? A. Well, in the oil industry, among other people, we have shipped to the Dow Chemical Company.

Q. About when, do you have any dates? A. I don't remember exactly when, but I have seen the invoices, so I know we shipped to them.

Q. Have you any idea when it was? A. Well, I think it was probably around 1934 or 1935.

Q. Any oil company? A. We have shipped—we did some business in the south, in the southwest, through Tulsa agents, whose names have escaped me for the moment, we

sold quite a little rodine down there, as far as I know to oil companies, but I cannot be sure of that. I have seen invoices where we shipped some Rodine No. 2 to the Gypsy Oil Company.

Mr. Owen: I would like, Mr. Lyon, at this point, if you would please have the witness identify a little more definitely these materials which were shipped to these different industries.

Mr. Lyon: Well, I will be glad to do that.

Q. If you can elaborate on that, Mr. Douty, or fill in that testimony that Mr. Owen asks for, if you can, give him what he wants? A. Well, the automobile industry got mostly body cleaners, containing phosphoric acid, alcohols, rodine and arsenic.

Mr. Owen: What were those body cleaners called? A. Deoxidine. They also got some Deoxiline.

Mr. Owen: Have you got the formula for those? A. Why, yes, but I am not so sure that I care to give it to you, because some of them are still in use.

Mr. Owen: They contain phosphoric acid? A. Yes.

Mr. Owen: And no other acid? A. No other acid.

Mr. Owen: What did you ship to the Dow Company? A. I am not sure that I know right now; either Rodine or Murodine, I can't remember which.

Q. What was Murodine? A. Murodine was a material, an inhibitor made under certain other patents not in suit here. It did not contain any arsenic.

Mr. Lyon: Did the—do you believe it corresponded to the claims of this counter-claim patent here in suit? A. I am inclined to believe that—

Q. (Interposing): It would depend how it was used, I suppose.

Mr. Owen: It would depend on what it contained. A. Well, in any case, it wouldn't correspond to the claims of the patent, because, as I recall, we didn't ship Murodine in steel at all.

Q. Do you remember whether you ever shipped any Rodine in steel to the Dow Company? A. I can't re-

member. If we ever did, it would appear in the deposition of Mr. Spruance.

Mr. Lyon: We will turn to a new subject now, Your Honor. I want to have the witness present patents which will be relied upon by the defendant as constituting the pertinent prior art ahead of the Grebe-Sanford patent in suit. I will try to do that as fast as I can. Of course, we are permitted to rely on such of those as the plaintiff has already offered in evidence, and I don't think it would be necessary for me to go over those again. But we have some others, and I would like to mark this group of patents as DX-294, and I will identify the patents at this time.

(Whereupon the group of patents referred to was marked DX-294.)

Mr. Lyon: Now, Mr. Douty, can you go through these various patents and identify which ones you are talking about and tell us in so far as they are pertinent here what they disclose and see if you can classify them in some way that will help the court. I have in mind if they only show inhibitors for corrosive acids, say that that is the classification they belong in. If they show adding inhibitors to acid for removing limestone scale, or some such particular purpose analogous to the Grebe and Sanford patent, that you call attention that they fall in that class. I think that will help the court the most, because I do not think there is anything very difficult about these patents, Your Honor. It is just a question of getting them classified and getting them in your mind. A. I had thought that logically the prior art patents really belong into three classes: those which indicate the general principles of inhibiting, what inhibitors have been used for, and how generally they have been applied; those which showed particular inhibitors mentioned in the patent in suit, the Grebe and Sanford patent in suit. Before I read any of these, or refer to any of the patents, I just want to go briefly over the list of inhibitors to which Grebe and Sanford specifically refer. Grebe and Sanford specifically refer, toward the bottom of column 1 of page 1, to arsenic acid, to arsenic trioxide, or a

soluble arsenate or arsenite. Toward the bottom of column 2 of page 1, Your Honor, they begin to tell what inhibitors they have in mind. And in addition to those arsenic compounds Grebe and Sanford refer to other inhibitors such as cyanides, organic nitrogen bases such as aniline, phenylhydrazine, pyridine, quinoline, acridine and derivatives thereof, organic sulphur compounds such as mercaptans, as well as various by-products of industrial processes, such as sludge acid from oil refining and residues from acid sulphite paper manufacture.

Referring now to the Laverty patent No. 856,644. That is the first one in the book after the Frasch patent, Your Honor.

The Court: Maybe someone will tell me, now that I am starting with this, was this both in the file wrapper and before the Tenth Circuit?

Mr. Lyon: Yes. This one was cited by the Patent Office and was before the Tenth Circuit. Laverty is obviously a practical man rather than a chemist, since he refers to the use of a pickling bath containing a hydrocarbon. Hydrocarbons are not soluble in a pickling bath, and don't do much good in a pickling bath; but on reading his specification one finds that the agent that he is interested in is tar sludge, it being a waste product of the oil refining process containing tar and oil and sulphuric acid. That appears at about line 35 of the first page. Now, it likewise appears from the line following that, (reading): "I preferably add the sludge to the acid generally about one part sludge to 15 parts acid by weight. This will give an excess of oil to the acid, the surplus oil being afterwards skimmed from the top of the bath."

Actually, that oil tar sludge contains a great many different organic chemical substances, and you will find, Your Honor, as we go along that many of the inhibiting agents proposed by other individuals are such industrial wastes as this tar sludge. If one consults the classical work on petroleum, Das Erdoel, which means petroleum, by Engler, one will find that oil contains, among other things,

nitrogen ring bases, and later on patents will be referred to which mention nitrogen ring bases as actually preferred agents to be used in pickling baths.

It will be found that there is a reference to tar sludge, I think, in the patent in suit.

The Court: Here is the reference in the patent in suit, (Reading): "Such as sludge acid from oil refining and residues from acid sulphite paper manufacture, etc." A. That is right, Your Honor. Well, now, with such agents, there is no guaranty that one of them will be as strong as another, or will contain the same ingredients as another, since they are industrial waste products.

The Court: But what you do say is that both patents refer to that ingredient or those ingredients? A. That is right.

The Court: Is there any difference between the two? They use different words there. What is your interpretation? A. I do not see how you can find any difference. He says that tar sludge is the material I preferably use. That is Laverty. On account of its cheapness, it being a waste product of oil refining process. I think that is the same product to which Grebe and Sanford refer. They refer to it as various by-products of industrial processes, such as sludge acid from oil refining. Now, obviously, a waste product of oil refining, being a tar sludge, is the same thing.

Mr. Owen: In the Gravell patent where it refers to nitrogen ring compounds, would that be the same thing as Laverty referred to? A. Not all nitrogen ring compounds, although ring compounds may be contained in the tar sludge. Line 50 of page 1, Gravell patent, he refers to—

Mr. Owen (interposing): That is the same thing Laverty refers to? A. Yes, all these inventors have been in the habit of reciting materials from the previous patent literature as examples of the things they mean. Grebe and Sanford and Gravell were no exception to the general rule. The object of that Laverty invention was to provide a pickling bath, among other things, in the use of which a scale or oxide is removed from the metal without appre-

ciably attacking the surface of the metal. He repeats that phraseology almost exactly in the second column of page 1, where the says: "the surface of the metal is not attacked by the acid in the bath to any appreciable extent during the time required to remove the scale from the metal." Actually, of course, crude materials of this kind are unable to afford awfully good protection unless they are used in very large quantities.

Mr. Lyon: But to be compared in what way to the object of Grebe and Sanford? A. The object as expressed there is identical with the object of Grebe and Sanford.

Q. You will have to tell us what it is. A. Namely, to remove something. We all know it isn't exactly the same as Grebe and Sanford in that in this case Laverty is interested in removing scale, as I talked about this morning, from the metal without appreciably attacking the surface of the metal. Grebe and Sanford are concerned with getting the acid down into the well without appreciably attacking the metal. The problem is similar but not identical.

Well then, the next patent is the one to Beneker, No. 914,916.

Mr. Babcock: Your Honor, that patent wasn't cited by the Patent Office but it was considered in the Williams Bros. case.

Mr. Owen: I have a note it was cited in the Grebe file wrapper.

Mr. Babcock: I may be mistaken.

A. The only thing I failed to say about the Laverty patent was he says "Other than sulfuric acid may be used and materials other than oils containing hydrocarbon"—in other words, he means any acid. Beneker disclosed the use of arsenic acid in a wire and metal cleaning bath. I mention it particularly because arsenic is a preferred agent of the Grebe and Sanford patent in suit, and also because Beneker gives a description here which might be helpful to Your Honor, of pickling in which he says before all the scale has been loosened the exposed metal has been vigor-

ously attacked by the acid. Beneker patent about line 20 of page 1. That is a description of the ill-effect that he is trying to avoid. He mentions around line 13 that the pickling bath may consist of sulphuric or hydrochloric acid. He mentions the use of arsenic in quantities as low as 5/1000% of arsenious oxide and he seems to prefer to use from .001 to .005% of arsenious oxide, line 65, page 1, where he says: "preferably from .001% to .005% of a compound of arsenic, as, for instance, arsenious oxide." I call Your Honor's attention to the fact those are very much smaller quantities of arsenic than are referred to in the patent in suit which refers to quantities in the neighborhood of from 1 to 5%. The reason for that is very large amounts of arsenic completely spoil the pickling operation. They coat the metal with an undesirable coating. They prevent the removal of scale from the irregularities of the surface and otherwise affect the desirable operation. That is a problem which does not exist when the acid may act upon a surface which does not necessarily have to be clean and beautiful after the operation, as in the Gravell or the Grebe-Sanford processes.

Q. Let's go to the next patent. A. All right, the Holmes patent No. 1470225. This patent is on the application of aldehydes as inhibitors. Aldehydes are not mentioned in the Grebe-Sanford patent, although I think they are mentioned in the Gravell patent. The principal matter of interest in the Holmes patent is that this is one of the early examples of the use of inhibitors for another purpose than merely pickling heat scale off of steel. At line 10 of page 1 Holmes states: "This invention is particularly applicable for the pickling of iron or steel wire or sheets in mill practice, but is also useful in many other ways, such as for cleaning or freeing iron or steel in any form from rust or oxides, or for removing scale such as boiler scale or the like from sheets or tubes."

Now, the meaning of that boiler scale is a deposit that is left by the evaporation of water in the boiler, and it consists usually of calcium and magnesium salts, and often is

not very far in composition from the composition of rock found in oil wells, or of common limestone. Therefore, the problem of freeing the boiler from boiler scale, or the boiler tubes of the boiler from boiler scale is very analogous to the problem of the patent in suit. You want to dissolve some type of limestone-like formation by means of acid which has to be transported in steel. In this case, one wants to remove the undesirable encrustation from the steel boiler without harming the boiler, and it is that particular analogous application for which I think this patent is most interesting.

Q. In either case, you want the acid to act on the lime material and yet the acid contains some inhibitor so that the acid will not eat or dissolve the iron? A. That is correct. And Holmes states that examples of suitable acids are sulphuric, hydrochloric, phosphoric and even acetic, although these weaker acids would probably not prove effective, that is, acetic and so forth. I was reading from line 60, page 1.

Q. All right. Let's go to the next patent. A. Next is the Gravell patent to which reference has just been had, and I don't think we need to go any further than that.

The Court: That is the defendant's patent in suit? A. Yes, sir.

Mr. Babcock: This patent was considered in the Patent Office and also by the Tenth Circuit.

A. The next is the Fischer and Stegemeyer patent, 1,736,282.

Mr. Babcock: That was considered both in the Patent Office and the Tenth Circuit? A. The interest of this patent is merely in disclosing still another class of inhibiting agents, namely, the reagents resulting from sulfonating mineral oil. As a matter of fact, the agents to which this patent refers are agents which are produced in the refining of very highly refined white oil, medicinal oil, and they are described by the patentees on page 1, at lines 61 and 62, as (Reading): "The sulfonic reagents resulting from this refining treatment are of very high molecular weight,

usually between 200 and 500, and are classified for convenience by their various characteristics of chemical behavior, such as their solubilities, etc. * * *

"Generally speaking, the bodies fall into two classes those which are oil-soluble in the presence of water, and those which are oil-insoluble in the presence of water."

And Fischer and Stegemeyer want to use the water-soluble members of this class as inhibitors in the pickling in an ordinary pickling operation.

Q. Now, does anything of the Grebe and Sanford patent correspond to those sulphonic reagents of Fischer and Stegemeyer? A. It is very probable that the sludge acid from oil refining of Grebe and Sanford, as well as the sludge acid of Laverty, contains some of the same compounds that are disclosed here by Fischer and Stegemeyer.

Q. Just exactly what sludge acid you would have would depend upon what you were treating with your sulphuric acid, wouldn't it, what oil, you were treating? A. It would.

Q. These fellows were treating a particular mineral oil? A. Yes.

Q. A medicinal oil, and the patent in suit of Grebe and Sanford does not say what they were treating; they just included all sludge acids, isn't that right? A. Yes.

Q. All right. Let us turn to the next patent. A. The next is the Rhodes patent, to which I have previously referred, No. 1,746,677.

Mr. Babcock: This Rhodes patent was not considered by the Patent Office, but was cited in the answer in the Williams Brothers case.

A. The Rhodes patent is of importance for two reasons. The class of inhibitors which Rhodes discloses are acridines, the formulas of a number of which appear in the first column of the second page of the patent. Acridine and derivatives thereof are mentioned at the top of the first column of the second page of the Grebe and Sanford patent. The second reason, and more important reason, for including Rhodes, is that Rhodes has given a fairly good exposi-

tion of the use and purpose of inhibitors. I should like to read first from the beginning of the Rhodes patent. (Reading): "The invention relates to inhibitors or restrainers useful in chemical and electrochemical processes for preventing or retarding the evolution of hydrogen at the surfaces of metals immersed in the solution or for otherwise preventing or retarding the chemical action of acids on metals."

That points out an interesting fact, that steel and the ordinary acid corrodable metals always corrode with the evolution of hydrogen in strong acid solutions, and anything which will prevent or retard the evolution of hydrogen at the surfaces will serve to prevent or retard corrosion. I wish to also call attention now to line 43 of the first column on page 1, where Rhodes says, after having described the use of his inhibiting agent in pickling, and so forth, (reading): "Another use of the process is in the removing of the metal oxide or carbonate forming on copper or other non-ferrous materials. Another advantageous use is in eliminating the scale forming in pipes and in the tubes of automobile radiators which often seriously interferes with the proper flow and circulation of the fluid through the radiator."

Now, that is another use which I consider highly analogous to the process of the patent in suit, namely, that you are to dissolve calcareous deposits formed by deposition from water on metal surfaces. In column 2, of page 1, at line 65, the patent reads (reading): "In its broader aspects, my invention contemplates the use of the inhibiting agents hereinafter more fully described in connection with any chemical or electro-chemical solution or reagent which under normal conditions of operation will evolve hydrogen at the surface of a metal immersed therein. In other words, my invention provides a means for causing desired chemical or electro-chemical reactions to take place and without substantially decreasing the rate of said reactions causing an inhibiting action retarding or actually preventing the evolution of hydrogen which would normally

take place without the presence of the inhibiting agents."

I think that might be written a little more clearly to say that he wishes to stop all processes which cause the evolution of hydrogen from an acid solution without stopping those processes which do not evolve hydrogen from solution.

The Court: Is there a definition in chemistry of agent and also reagent, so I can have that? A. Well, an agent isn't strictly speaking a chemical term at all. An agent is just a general term which means any person or thing which performs a function which is desired. A reagent is a substance which enters into a reaction, obviously with some other substance or substances.

The Court: Substance or what? A. Enters into a chemical reaction. Anything which enters chemical action with anything else is a reagent.

The Court: Hydrochloric acid and this limestone? A. They are both reagents. Hydrochloric acid and steel both the steel and acid are reagents.

Q. (By Mr. Lyon): You have said this Rhodes patent specifies the use of acridines. Compare that with the third reagent or agent specified at the first line on page 2 of the Grebe-Sanford patent. A. "* * * acridine and derivatives thereof," which appears in the first and second lines of page 2 of the patent in suit, Grebe and Sanford patent, describes the materials that Rhodes here refers to.

Q. So both Rhodes and Grebe and Sanford, so far as acridines are concerned, call for the same inhibitors? A. Yes, sir. The next Rhodes patent, No. 1,746,676, I will not refer to in any detail. It recites certain other acridine derivatives.

Q. Otherwise the disclosure has the same effect as the preceding Rhodes patent? A. It has. In fact, it is almost verbatim the same as the other one except for the actual agents therein disclosed.

The next patent to Vignos, No. 1,750,651.

Mr. Babcock: It was cited in the Patent Office but it wasn't considered by the Tenth Circuit.

A. The Vignos patent is cited for two reasons; in the first place, the preferred agents of Vignos are sulphonated mercaptans. Now, mercaptans, without reference to sulphonation, are referred to in the Grebe and Sanford patent on line 3 of page 2, such as mercaptans, it says: "organic sulphur compounds, such as mercaptans." These compounds of Vignos are still mercaptans. They are sulphonated mercaptans, he says, and for that reason I mention them. Vignos also recognizes the usefulness of his inhibitors, in quoting from line 21 of the first page: "The removal of deposits collecting within a water or steam circulating or distributing system, and also for removing scale such as boiler scale and the like from sheets and tubes." And Vignos also recognizes that these inhibitors may be added to the acid transported in an acid tank car to prevent corrosion of the car by the acid and can likewise be used to diminish excessive corrosion by water in systems employing mine waters, which is getting pretty close to what you are trying to do in the patent in suit.

Q. I think if you just tell the court what inhibitors these patents called for, as you come to them, and for what purpose, that would be all that you would have to testify to about them, because they can always be read, and I think those are the pertinent things that the court is interested in. A. The Harrison patent, 1,766,902, relates to an inhibitor from the 1-2 Dianimo ethane. It mentions a number of derivatives, and it is used for pickling operations, and it says on line 7 that it is also useful for cleansing tubes from scale by pickling and for removing the scale and corrosion products that accumulate in water pipes, and it may be used in any case where iron or steel is to be freed from rust or oxides, or wherever it is necessary to treat iron or steel with acids and solution of the metal is undesirable. It says that it is useful in any case in which it is necessary or desirable to use acidic materials in contact with iron or steel.

The next patent is Corson and Lawrence, 1,773,953, and refers to a certain special type of sulphonation prod-

ucts of mineral oils, which contain in the neighborhood of 10 per cent or more total sulphur as inhibitors. They are ichthyol-like materials. They are in the class of organic sulphur compounds, but not very closely related to any of the other materials mentioned in the patent in suit. It is also stated that they are useful in removing undesirable encrustations and corrosion products associated with metals which are submitted to acid treatments, and it says on line 69: "There are, however, many other processes in which acids could be used to dissolve rust or encrustations upon the metals." It mentions the use of the materials in hydrochloric acid.

The next patent to Lawrence, 1,780,594, refers to the type of inhibitors known as the thioglycollic acids. Its derivatives contain the radical $COOH\text{-}CH_2\text{-}S$. And once more it refers to the general use of inhibitors to remove either oxides, rusts, scales, salts or other undesirable encrustations and corrosion products.

The Court: One would think many of these are almost identical. I suppose, if you come to read them, there is some theory on which they claim an improvement on the previous one.

Mr. Lyon: We are really putting them in here, Your Honor, just to show that these various agents, that all the inhibitors that are mentioned in the Grebe-Sanford patent and many others are all known to be inhibitors, and then to show that as to certain of these patents that they were known generally for uses wherever the acid contacted the metal, and, specifically, many of them describe where the acid is acting on a lime material. They don't really add very much to the Gravell patent that our counter-claim is on. I think that is really the most pertinent prior art patent for Your Honor to consider.

The Witness: This is another one of a large class of organic sulphur compounds.

The next patent to Lawrence adds no new ideas to the ones that we have just described and disclosed. And it claims to use as inhibitors compounds which are known as mustard oils, the isothiocyanates.

The next patent to Calcott, 1,785,513, is of interest because it mentions specifically the use of mercaptans, which are of the class of agents described in the patent in suit, and which have been mentioned here as having possibly been used by the plaintiff. The patent specifies generally the treatment of metals with acids, and this is on line 10—"For the purpose of inhibiting this solvent action on the free metal, certain types of substances have been added." And it goes on to say that these mercaptans are particularly effective.

The patent to Burke, No. 1,789,805, patents the use of alpha amino acid, and particularly substances derived by hydrolizing animal proteins which include the particular albumenoid protein, keratin. It is interesting only because it is another, still another of the large class of inhibitors which, however, can be related to a much earlier inhibitor that is mentioned in the art, namely, gelatin, since gelatin is one of the proteins which is hydrolized in hydrochloric acid to give you certain amino acid. In the second column of page 1, at line 64, a paragraph begins which speaks of the transportation or storage of acid solutions in metal containers. This patent, of course, was filed in 1929; it was some years after the Gravell patent had issued.

Nextly, the patent to Corson, No. 1,809,621, mentions a type of chemical inhibitor not heretofore mentioned, namely, the thiuram compounds, notably the thiuram sulphides, and it makes quite a point of the removal of scale or other acid soluble deposits from metallic articles.

Now, I think that closes all of the patents which refer specifically to inhibitors.

Mr. Lyon: We have a stipulation which I would like to read in evidence in this case, which is page 61 of the deposition of Mr. Boundy, taken in Midland, Michigan, on July 25, 1940, which reads as follows:

"It is hereby stipulated by and between the parties to this litigation that in all the work done by the Dow Chemical Company, or anyone in its employ, or on its behalf, prior to February, 1932, no inhibitor of any kind, nature

or description was used in connection with the acid used in the treatment of brine wells, and the reports and records of the Dow Chemical Company so show.

"Mr. Owen: The proposed stipulation is accepted."

Mr. Lyon: Now, Mr. Douty, you have called attention to these prior patents. I would like to have you tell us as a matter of your own knowledge, and to what extent inhibitors were being used with hydrochloric acid prior to more than two years before the application for the Grebe and Sanford patent in suit, what use was being made of them commercially, and for what purposes, and to what extent, to your knowledge? A. Prior to approximately 1930, in other words, some time in 1930—well, I know that at that time we were selling inhibitor to some people who pickled with hydrochloric acid. We were selling inhibitor to others who were removing various types of calcareous deposits from equipment of one kind or another, with hydrochloric acid. I am not going to be able to tell you to what extent, because I do not know relative to our whole business how much of it went into these particular uses that I am describing, but I know that it was used—

Q. (Interposing): You know that you were selling those materials for commercial use? A. Yes. Now, I also know that on at least one occasion, and I do not know how many more, the acid was sold to be used for some purposes in connection with an oil well, down an oil well.

Q. Who was that sold to? A. Well, I have seen the records of the Gypsy Oil Company sales where they used acid, as I have been told later, for cleaning out—or freeing tools or removing gyp from the pipe. Prior to 1930, or September, 1930, I can't think of any other uses in connection with hydrochloric acid at the moment, and I don't know the extent of the use in any case.

Q Were others selling inhibitors? A. Yes.

Q. Your own company was selling inhibitors, was it not? A. It was.

Q. Beginning when, as far as your knowledge is concerned? A. As early as December, 1923, and continuously thereafter.

Q. And did you have competitors in that business? A. Yes; we have had a number of competitors. The Grasselli Chemical Company sold inhibitors. I don't know exactly when they began to sell. But I know they have been doing it for a number of years.

Q. Well, they were doing it before 1930? A. I am sure they were. How much earlier, I don't know. The Barrett Company were selling inhibitors pretty far back. Then—let me see, I don't remember just when William M. Parkin began to sell. William M. Parkin of Pittsburgh. And a fellow named Addison Hoffman of Pittsburgh. And I think Parkin used to sell things for him. We have had altogether some thirty or forty competitors. Some of them are still in existence. Most of them aren't.

Q. Then you can state that this knowledge of the use of inhibitors was not confined to the patent art, but was actually commercially practiced prior to 1930? A. Oh, yes.

Q. On a wide scale, for various purposes, to protect the metals from the corrosive action of the acid? A. Oh, I am sure of that. I know that in February of 1930—on January the 3rd—let's see, it says here—I think that must be a mistake. It says Friday, January 3rd, 1929, I was supposed to have delivered a paper on the use of inhibitors in the pickling of steel before the Philadelphia Branch of the American Electroplaters Society. Now, whether that was 1929 or 1930, I can't say now, because this is the February, 1930, issue of the Quaker City Platers Reminder from which I am reading. Immediately under the title of my article it says "Friday, January 3rd, 1929." I can't say which year that was. But, in any case, at that time I read a paper on inhibitors in which I told something of the art, and apparently it was not particularly mystifying to the platers who were at that meeting.

Q. Was that paper printed and published? A. Yes. This is a copy of it.

Mr. Lyon: I will ask that that be marked DX-295.

(The copy was thereupon marked DX-295.)

Q. (By Mr. Lyon): You have referred to the sales

to the Gypsy Oil Company. We already have in evidence these exhibits at page 459, 461 and 463 in the appellate record in the Williams Brothers case. Are those photostatic copies of the records you had in mind? A. They are.

Mr. Lyon: These are the orders from the Gypsy Oil Company, Your Honor, to Mr. Douty's company. For the Rodine No. 2 which Dr. Wescott recommended be used in the treatment down in Oklahoma. I think those are already in evidence. If they are not, I will declare them so now, with Your Honor's permission.

The Court: All right.

Mr. Lyon: Mr. Douty, in preparing that article or address of yours which we have just referred to a few moments ago you made quite a study of the history of inhibitors, did you not, and where they were first known and the extent to which they were known in past history? A. I read what literature was available on the subject.

Q. Now, there has been some suggestion here about what was known about inhibitors at the time of Frasch. The work Frasch was doing, Frasch applied for a patent on June 27th, 1895. Tell us what was known about inhibitors at that time, what was known—or might have been known in scientific literature and whether they were in use or commercially known at that time? A. In that paper that has just been marked as an exhibit, Your Honor, you will find that the earliest reference to the commercial use of inhibitors, as they are called today, that I was able to find, was in the early twentieth century, starting somewhere around 1907 or 1908. To be sure, I found as early as 1845 a paper by a Frenchman by the name of Millon in the Comptes Rendus, on a memoir upon the action or water on metals in the presence of acid and salts. That, indeed, did mention that certain metals had either accelerating or retarding effects upon the rate of solution of metals, different metals, in acid. But, it was a purely scientific observation which, as far as I know, no technical use had been made until 1896; I think I rechecked that date, and that was the date when this fellow Meurice published in the

proceedings of the Belgian Chemical Society an article in which he described the effects that he had obtained with arsenic in the pickling of wire in his mills. Now, that is the earliest article that I was able to find which mentioned any practical use of any inhibitor. That use was in a Belgian wire mill, as far as I was able to find out.

Q. Well, as far as your search revealed, could you find any reference to the commercial use of inhibitors or knowledge of inhibitors in the United States back at the time of Frasch's work in June, 1895? A. No, none at all.

Q. And do you believe your search was a thorough search? A. I think it was a fairly complete search. I think it was in 1901, or somewhere along there, that an investigation of the effect of arsenic was made by Burgess, but I may be mistaken in that date. It was certainly in the 1900's, and even then there was no commercial use of it so far as I know. Beneker's patent came out in 1909, in March, 1909. It was applied for not over a year or so earlier, and to be sure I had heard from old picklers by word of mouth rumors of the addition of certain things like mouldy flour and things of that kind to produce a foam on a pickle bath further back, but they could not be sure of the date, and when I asked them it was in the 1920's, and how far back that experience really went it was impossible to say. I could find nothing written on the subject earlier than the twentieth century.

Q. You couldn't find any record of the sale of inhibitors in this country or the existence on the market of inhibitors prior to what date? A. Well, as a matter of fact, I don't think that there was a commercial inhibitor sold in this country before 1920.

Q. And who made the first sale, as far as your knowledge goes? A. I am not sure but what the material was known as Picklette, and it was a solution of coal tar bases extracted from anthracine oil, and I wouldn't be surprised if it had been put on sale by the American agents of an English firm.

Q. About 1920? A. Yes.

Mr. Lyon: While we are about it, I don't think this Williams Bros. record has been given a number. Only parts of it are in evidence; the record shows which part, but under the practice it should be offered. I will ask that it be stamped DX-297.

(Whereupon Exhibit DX-297 was marked by the reporter.)

Mr. Lyon: Before I ask you to give your conclusions from the corrosion curves that Mr. Hathorn has produced, will you please tell the court what experience you have had in making corrosion tests and interpreting and understanding the results of corrosion tests, how long have you been doing it and to what extent, and to what extent you are familiar with the procedure and interpreting the results? A. Starting in 1923, in the late summer, I began to make corrosion tests, particularly tests on the corrosion of metals, particularly steel, with acids, very extensively. And I continued making hundreds and thousands of such tests by various techniques, some of which I developed myself, up to and including the present day. For up to the period up to about 1930, I would say there was scarcely a working day where I did not make half a dozen such tests by one means or another, one method or another. Some of the earliest work I did on corrosion by acid had for its object the determination of conditions under which metal surfaces could be made—brought into such a condition as to make corrosion tests more or less uniform and reproducible.

I think I will state the conclusion first, that I never found such conditions. I have tried every conceivable method of cleaning and pre-treating and it almost works down to the fact that you have got to get—to reduce the thing down to a statistical average before you can believe very much of any corrosion series. Among other things that I thought might be very uniform for the purpose of testing for corrosion was piano wire. I thought music wire from one roll of very fine music wire would be about as uniform a specimen as I could possibly get. Well, I found that any results you got from such a piece of music wire,

within any reasonable period of time, failed to check each other by fifty per cent or more, repeatedly. And it has been my experience throughout that only by the very greatest precautions as to reproducibility can you get results that are at all close together, particularly when you are trying to measure interference with normal corrosion rates by the presence of accidental or intentional impurities. I won't go into it any further, except to say that it is a subject with which I am quite familiar.

Q. In connection with your work in preparation for this case, I understand you were able actually to devote only a limited amount of time to your preparation, is that correct? A. Very little time.

Q. You didn't have time to stop your other work and run a six months' or a year's series of tests to prepare for this case, is that right? A. Nothing like that.

Q. Well, did you have time to make any laboratory tests? A. Yes, I made some laboratory tests whose object was to find out whether the Menaul process under the best conditions could actually be operative. I recorded those tests and the results thereof in a laboratory notebook which I produce. (Producing book.) As a matter of fact, this particular book has a variety of things in it. It is just a loose-leaf notebook, but every single bit of data that I have I will now produce (handing sheets to Mr. Lyon). That is all. The rest of the notebook is filled with notes taken at this trial.

Mr. Lyon: These sheets seem to be numbered or lettered "A" to "W," consecutively, and then there are six more sheets. That will give anybody wanting to count them information as to whether they are all here or not. I will ask that these be received and marked DX-299.

(The sheets referred to were marked DX-299.)

Q. (By Mr. Lyon): These notes, or these writings, constituting DX-299, are all in your own handwriting, are they? A. Yes, sir. They contain my conclusions, any conclusions that I reached as a result of those tests. I ran four series of tests here—

Q. (Interposing): Will you just explain to the court what the tests were and what conclusions you drew from them? Of course, the exhibit itself is in evidence, but just give the court a summary, if you will, please. A. The first three tests were intended to evaluate the effect of the contact of a piece of steel with lead in protecting it from attack by 15 per cent hydrochloric acid, and they were made under various conditions of contact and time, so that I was trying to isolate, if any, the effect that the dissolved lead chloride might have, and the effect that the electrical connection might have, and the fourth test, which repeated the first one, was made much later. These tests were performed in December of 1939, and then I did no further work except for several days in June of 1941 when I did the fourth test. That was the first time I ever heard about copper having anything to do with this case, so I made some tests involving the use of copper in proportions somewhat larger than had ever been found in any of the defendant's acids as reported to me. So that I have four tests here of a Menaul system, really, and variations of the Menaul system, in order to find out. Then I find in this notebook also a few measurements of the potential of lead versus steel in hydrochloric and sulphuric acids, which have not been transmitted to anybody else, but which I simply found in these notes.

Q. But they were made by you? A. All made by me. All this work was by me, helped by nobody. All on a laboratory scale.

Q. Now, will you just give us what your findings and conclusions were as they are expressed in the exhibit? A. At the conclusion of my first test I had reached the following conclusions:

1. Lead chloride is a slight inhibitor of the corrosion of steel by hydrochloric acid of the strength used by oil well treaters.

2. Connecting the steel to a piece of lead protects the steel far more perfectly than does adding lead chloride to the acid.

3. In acid containing lead chloride the protection afforded the steel by connecting it to a piece of lead is not only not improved but is actually impaired by the presence of the lead chloride.

The Court: I think I understand that, but the two conclusions seem inconsistent. A. They would, Your Honor.

The Court: In other words, at first I had the idea the lead connected to the iron was better than the lead flowing loose in the hydrochloric acid? A. That is right.

The Court: Then I get down to the second one and it is just the reverse of that, isn't it? A. I think Your Honor will understand the conclusions better when I describe the experiments. They are very simple and I think conclusive.

The Court: All right.

(Witness continuing): The fourth conclusion is—lead chloride dissolved in the acid does not produce a continuous, adherent film of lead on the steel.

5. Steel connected to metallic lead acquired in the acid an adherent, apparently continuous film of lead. Incidentally, I base that not upon any analysis of lead but based upon an actual difference in weight, which is considerable. In other words, a piece of steel was weighed at the beginning of an experiment and at the end of the experiment. In addition to that, the solution is analyzed for iron at the beginning and end of the experiment. Now, the loss in weight of the steel should be the same as the increase in iron in the solution. But it turns out that when the steel is connected to lead, the loss in weight of the piece of steel is considerably less than the amount of iron found in the solution. Now, that means that the steel must have lost some weight of iron and gained some weight of something else. Otherwise, it would have lost as much weight as the iron I found in the solution.

The Court: Iron has to get away somewhere. A. It did go away and yet the steel didn't lose that much weight. So I was able to weigh that difference in a number of experiments and conclude the steel had from 3 to 5 millionths of an inch of lead on it at the end of the experiments.

Mr. Lyon: You were reviewing your laboratory work, Exhibit No. 299, and I asked you to make a summary of the work and read the conclusions as you arrived at them and recorded them in this exhibit, and I think you had just finished reading the conclusions on your first three experiments, which were, as I understand it, experiments you did to determine the effect of bonding steel to lead. A. Mr. Lyon's question was not exactly correct. I had only read the conclusions which occurred at the end of the first experiment that I had run. I then ran a second experiment, and at the end of the second experiment I had not arrived at any further conclusions in quite the same form. I ran still a third experiment, and after I had finished the three experiments I had confirmed some more ideas that I had had. I think before discussing the conclusions, I had better state briefly what tests I made and what they were. They were entirely laboratory experiments. The object was to find out the rate of solution of iron from ordinary tank steel in plain acid, where the steel panels alone were in the acid. In plain acid, where the steel panels were resting in contact with lead strips, and in plain acid where the steel panels were in the same beaker with, but not in contact with the lead, and then a second series of three in which the acid was initially saturated with lead chloride. That is, I had put in as much lead chloride as the acid would take up, and then the steel panels, certain steel panels were placed in a beaker full of that acid alone and another beaker containing a lead strip and in contact with a lead strip, and in a third beaker—in the same beaker, with a lead strip but not in contact with it. The way that was done, I cut three inch squares of tank steel of 14-gauge, which is about 78 thousandths of an inch thick, and lead strips about 1½ inches by 10 inches by ⅛th inch were bent into a "U" shape about three inches across the top of the "U" and the arms about three and a half inches long.

In those experiments where the steel was in the beakers alone, I chose beakers of 600 milliliters capacity in which the three-inch squares of steel would stand on the

bottom not quite erect, because they would rest against the curved sides of the beakers. In those experiments where the lead strip was to be in contact with the steel, the lead "U" was first placed in the beaker with the arms upward. The steel was then placed resting upon the "U" on the bottom of the beaker and leaning over to one side, and one arm of the "U" was then bent over so as to make contact with the steel square at the top as well as at the bottom, so that the steel square rested on the lead at the bottom and also rested against the lead at the top. Just to complete the record, the experiments were run at 90 degrees Fahrenheit, the beakers were placed in a thermostated air bath and the temperature was kept constant to within four-tenths degrees. The acid used was very close to 15 per cent acid. I record it as 4.37 normal. I started with chemically pure hydrochloric acid. The panels as they came to me were cut out of a piece of tank plate and had their original scale on them. Before starting the tests they were pickled free of scale in acid of approximately the same strength as was used in the test, which took three minutes. They were then washed with water, with dilute tri-sodium phosphate solution, again with water, and then with alcohol, dried and weighed on a chemical balance. The lead strip was scraped clean with steel wool and dipped for one minute into one to one hydrochloric acid, washed in water, dried with alcohol before the test.

In this first test each type of test was run in duplicate and the panels were allowed to remain in the acid under the conditions specified for 15 hours. The panels were then again washed under the tap, scrubbed with a bristle brush under the tap, and washed with dilute alkali, again with water, then with alcohol, dried and reweighed. At the conclusion of the test, the solutions were all analyzed for iron by titration and the loss in weight of the panels was compared with the amount of iron found in the solutions at the end. As an example of the type of results that were obtained, I have expressed the losses in weight as a per cent of the loss, a per cent of the original weight of the

panel, because the panels, although they were cut fairly accurately to 3″ square weren't exactly of the same size, and therefore since almost the entire area consisted of the large flat sides, the sheet being all of the same thickness, the weight of the panel was closely proportional to its area and therefore the best way to express the results was as loss in weight as a per cent of the original weight. The results are these: When the steel only was exposed to the plain acid the panels lost on the average 2.954 grams—I mean per cent of their weight.

The Court: That isn't grams? A. That isn't grams. That is per cent of the original weight. In other words, they lost about 3% of their original weight. When the steel was touching the lead the panels lost an average of .0172% of their original weight.

The Court: What is that? A. .0172%. In other words, something around 1/200 of the loss in the first case. I want to call to your attention, Your Honor, those were not the actual losses in weight. Those were the amount of iron found in the solution at the end. The amount of iron dissolved expressed as per cent of the original weight.

The Court: Well, is that .0172%—A. (Interposing): That is per cent of the original weight of the panel, Your Honor.

The Court: Before this experiment? A. Yes, sir. In the third case, where the steel was in the same beaker but wasn't touching the lead, the average loss was 1.934% of the original weight of the panel. Now, in the second series of experiments where the acid used was originally saturated with lead chloride, when the steel alone—

The Court (interrupting): Now, let's see. This is the one where you started out. A. This series of 3 tests which I have labeled D, E and F, were all run with acid which was originally initially completely saturated with lead chloride.

The Court: In what per cent? A. It was still the same acid, Your Honor, in strength—15% acid, but the lead chloride at 90° F. in that acid, lead chloride is soluble to

the extent of approximately 10 grams per liter, somewhere around that order. In other words, around 1%.

The Court: The second one is going to be saturated in lead to start in with? A. Yes, sir. That is about one per cent of the weight of the solution. The panel where the steel only was present in the beaker lost 1.870% of its weight. The iron dissolved was 1.870% of the weight of the panel. Where the steel was touching the lead, the loss of iron was .243%. I have it here .2426, but I don't think that number means anything beyond about two significant figures, anyway, if that much.

Then the third experiment, where the steel was in the same beaker but not touching the lead, the panel lost 1.409% of its weight. Now those are the averages of two experiments carried out to an absurd degree of accuracy but they are simply what I found. Now, you will notice the significant thing about that test is that comparing experiments A and B in which plain acid the steel was either touching lead or not touching lead, we have only about somewhere 1/60 times as much attack when the steel touches the lead; in the second case where the bath was originally saturated with lead chloride we have somewhere around 1/9 as much attack, relatively speaking. In other words, as far as that particular experiment goes, the relative protection was far less when the lead chloride was present.

Now, an interesting thing about these experiments was this—when the panels were observed after the operation it was noticed that those panels which had been in plain acid or had been in contact with acid saturated with lead chloride but which had not been in contact with metallic pieces of lead, they were generally etched, they were dark in appearance, had a loose film of carbon-like smut which easily washed off under the water tap with a soft brush. The panels were slightly rough to the feel, to the touch. The panels which had been in contact with the metallic lead during the immersion were a clean gray in color, they didn't have any smut, and they felt greasy to the touch.

Without going into the details, after making a few experiments, and then analyzing the accuracy with which my analyses for iron were made, I found that I could not possibly have made an error in my iron analyses that would have been greater than about two per cent of the amount of iron determined; and for small amounts of iron, I could not have made an absolute error in the amount of iron determined greater than approximately a few milligrams at most. In comparing the actual losses in the weight of the panels with the amount of iron found in a solution, I find that in experiments, A, C, D, and F, the ones where the iron did not touch the lead, the quantities of iron dissolved compare with the loss in weight of the panel in every case, within about one per cent or less. However, in the case of the panels which have been touching the lead strip, it turned out that the iron dissolved exceeded the loss in weight of the panel by a considerable amount.

In the case of the panels in the second test, the average was approximately 95 milligrams; that is to say, that the panel must have gained weight in lead some 95 milligrams. In the case of experiment E, where the lead chloride was present, the average was about 160 milligrams. So that, computing that with the regular density of lead, that would mean that the panels were coated with approximately three to five millionths of an inch of lead.

The next experiments after these were in an attempt to find out why the protection in the presence of the dissolved lead chloride was not as good as it was in the absence of the dissolved lead chloride; and they lead to this conclusion in the second experiment, that is, the second experiments were carried out in approximately the same way as the first, except that I omitted the series in which there was lead in the beaker, but not touching the lead strip; and I left that experiment go on for a total of 96 hours, analyzing the solution at 24, 72 and 96 hours, and at the end weighing the pieces.

And I found that where lead chloride was absent from the solution to start with, gave protection, good protection

for the lead which lasted about twenty-four hours and began to break down before seventy-two hours. But I found that in the case of similar solutions in which the lead chloride—the solutions were originally saturated with lead chloride, that the latter failed to give very good protection for more than about twenty-four hours. Even at that time, protection was beginning to fail, and I ascribed that to the fact, which was easily observable, that the junction between the lead and the iron, which was formed merely by gravity, had been spoiled by a growth of lead chloride crystals and the lead had become insulated from the iron. And it didn't occur very much if at all in fifteen hours, but it occurred pretty completely in twenty-four.

So I then set up a third experiment in which, instead of using the system that I have described, I made a small hole in the top of the panel and I hammered the lead through with a hammer, through the hole on one side and bent the strip over on the other side, and hammered it down, kept upsetting the lead and hammering it until I had an exceedingly tight joint, and then bending some in a self-supporting piece which held up the strip in contact with the lead, and then ran the experiment again, for a total, in this case, of ninety-two and a half hours.

In that second case, I found protection, perfect protection was obtained in both solutions which had lead chloride in them to start with and those which did not; for a period of twenty-two and a half hours. Quite good protection was obtained for a period of sixty-eight hours. But that protection was beginning to fail before the end of ninety-two and a half hours, and that the assembly had—the steel assemblies had become loose with the lead so that the contacts were broken. And I was able to conclude from the over-all set up of the experiments the things that I read in the first place, and also that if you don't make a very, very excellent bond between lead and iron you are going to destroy your protection quite soon.

Every one of the experiments, however, indicated that the total iron dissolved was greater where the solution was

initially saturated with lead chloride, that is, for those cases where the steel was touching the lead and when it was not. And that persisted for all three of the experiments, particularly—for all three of the experiments.

The fourth experiment was carried out in exactly the same way as the first experiment described.

Mr. Owen: Have you given any figures on the third experiment? A. I haven't given any figures, Mr. Owen. I don't think reading the figures into the record is going to make the picture any clearer. I will give you the figures, and if you think you can—

Mr. Lyon (interposing): They are all in your exhibit? A. All in the report. I don't think reading them into the record adds anything to the picture. The fact is that bonding the iron to the lead gave very good protection. Not as good protection, quite, when there was lead chloride present. And that the protection would last as long as you could maintain the bond. And that the bond had a bad tendency to fail.

Now, my fourth experiment was made in June of 1941 whereas the other three were made in December of 1939. I made this in a considerable hurry, because that was the first time I had heard that copper was supposed to be a factor in this picture, and before I came out here to Bay City I wanted to know how this Menaul effect behaved in the presence of copper. So I set up the thing again exactly as I did in Test No. 1, except not having very much time I simply set up individual pieces, not even in duplicate, under exactly the same six conditions that I have described in the first experiment. The solutions I used were these: I used for the experiment first—for Experiments A, B and C, under the fourth test, plain C. P. acid. For Experiments D, E and F, I used C. P. acid to which had been added, as chlorides, 500 parts per million of lead, five parts per million of copper, and 500 parts per million of iron, which were quantities a little bit larger than the largest quantities reported by the plaintiff here for any of defendant's samples. And the net result of that experiment was to give me results which led to about the same conclusions.

That the protection afforded by the contact with the lead was to reduce the attack about 1/160th of its original value, whereas the dissolved metals reduced the attack to about half of its original value. And, the protection afforded by contact with the metallic lead was reduced to 1/50th of its original value instead of 1/160th of its original value in the presence of the dissolved metals, and the absolute amount of iron dissolved from the panel was .0175 grams in the case of the panel immersed in plain acid.

Mr. Owen: Is that grams or per cent? A. That is grams. If you want it in per cent, it was .02 per cent of the weight of the panel, and in the case of the second panel which was immersed in the acid containing the lead, copper and iron, the loss was .0287 grams or .03 per cent. The values are quite small, but curiously enough they accord very accurately with the other small values that I found in the other experiments which compare the loss in weight of the specimens which were in contact with lead when the acid was plain and when the acid originally contained dissolved lead chloride. That was all these experiments were designed to prove, and I think that they show, as far as these conditions go at least, the presence of lead chloride, all the way up to saturation, of lead chloride, copper chloride and iron chloride together in proportion somewhat greater than those specified as the maximum found in defendant's truck tank samples in no way assisted the action of the Menaul system, but actually were detrimental to it.

Q. Now, have you completed reading all your conclusions in Exhibit 299? A. Yes, sir.

Q. As to the actual values that you determined, that is to say the amount of losses, the amount of dissolved iron that you found as a result of these experiments were comparable at all, how do they compare with the values that are set forth in Dr. Bartell's reports as found by him? A. Well, of course my steel samples were not the same as his, nor were they prepared in the same way as his, and yet I would say in general my results accord very closely with Bartell's, where they are comparable.

The Court: You get it in percentages, the amount of the solution, taking the reaction in percentages of the weight of the mass of iron, as I understand it? A. Yes, I did that, Your Honor, because the pieces were not identically the same size, and that was the best way you could compare them. The percentage didn't have any reference to rate of attack, except simply to show you how much of that particular piece dissolved during the period of test.

The Court: But it does depend really, what we are really interested in is how much a given surface was attacked, isn't it? A. That is right, Your Honor. However, I gave you the thickness of those panels, Your Honor. They are about 78/1000ths of an inch thick, so if it loses three per cent you can see how much it would lose in thickness.

The Court: Yes.

Mr. Lyon: Now, have you examined Mr. Hathorn's curves, Exhibits 280 to 286, and are you prepared to tell us what they reveal and what significance they have? A. Yes, I have.

Q. First as to the effect on the corrosiveness of the acid in the Menaul tank, what do these curves show or establish in your opinion as to the function served by and the result obtained by the bonding of the lead plate to the steel of the tank? A. I think the curves show very definitely that the connected lead plate greatly reduces the rate of corrosion.

Q. Will you review upon the curves and point out wherein you find such a showing, or find your statement substantiated by the curves? A. Before I begin I want to say that in general I can draw I think five conclusions that have some merit from the experiments which were conducted on what are here referred to as hard steel tanks. As to the experiments conducted on soft steel tanks, I think I am able to draw only one conclusion that I would like to stand on, but we will start with the experiments conducted with these hard steel tanks, which it has been testified are made of the same metal out of which defendant constructs its transportation tanks. Now, by comparing curves 1, 2

and 3 of Figure 1, one arrives at a range over which all commercial acid seems to corrode this particular type of steel. In other words, there seems to be a uniformity of experiments—there seems to be a range within which one can expect two experiments to agree (indicating). If we then compare with those Nos. 4 and 5, in which the tank was connected to the lead plate, that again would be a range within which individual experiments may vary. But since the range seems to be fairly well outside the range of experiments 1, 2 and 3, we can conclude that the bonded lead plate has substantially reduced the amount of corrosion going on in the tank. Whenever I say "lead plate," I mean "bonded," unless I say "disconnected," because I now come to the second conclusion, and I wish before going on to the second conclusion to have Your Honor look at sheet 2, DX-281—I was previously referring to DX-280. Now, referring to DX-281,—we have only one result on this chart, namely curve No. 1, for commercial acid alone. We know from examining this exhibit that there will not be any irregularity in the amount of the attack of that commercial acid within a considerable range, but it is also clearly apparent that the installation of a bonded lead plate as shown in curves 3 and 4 certainly gives a marked reduction of corrosion. Now, referring to sheet No. 3, which is Exhibit 282-DX, we can once more compare curve No. 1, which refers to the rate of attack by commercial acid alone, with curves 3 and 4, which refer to the rate of attack by commercial acid in the tank which is furnished with a bonded lead plate.

(Indicating): Now, returning to Defendant's Exhibit 280, which is sheet 1, we find on referring to curves 4 and 5, which are for tanks containing bonded lead plates, when the bond is severed at the end of 24 hours, we know that there is a sharp rise in the rate of corrosion. That indicates with certainty that the lead plate was getting some protection electrically, not chemically, because the solution remaining in the tank at the end of the experiment is the same solution, and this change in slope certainly indicates

that electrical protection has a part in the protection. In those two instances, the tank was not cleaned after the disconnection, and therefore it might have been coated with lead or other factors may have—to which I will refer later —may have had a part in the fact that these new slopes are perhaps not identical with the mean of the slopes for commercial acid. However, one can see from these, in the case of curve 4, after the disconnection, one had a rate of corrosion greater than the rate of corrosion of the commercial acid in the plain tank.

Q. Before you go any further I think it would be helpful if you would answer one other question, because you have answered a question as to the effect of the bonded lead plate on the rate of corrosion in the acid in the tank; but so that you can also cover my second question while you are going through these curves, and not have to go through them again, I want to ask you my second question, and that is, what do these curves show or establish as to the corrosiveness of the tank acid after the bond is disconnected? In other words, disconnecting the bond by severing the connection in the tank, but removing the acid from the tank, as compared with the rate of corrosion of commercial acid? A. As I have said, within the limits of variation of the individual experiments, I would say that these curves establish that the acid which had been in the tank system containing the bonded lead tank (plate) was at the end of such a period essentially as corrosive as it was before it had been in that tank. That is likewise well shown in Sheet 2, Exhibit 281, by the change in slope of curves 3 and 4 after disconnection. It is to be noted that in the case of Curve No. 3 the acid was removed from the tank, the tank cleaned, and then put back in the tank again. It is seen that the slope of Curve 3 is not far different than the slope of commercial acid shown in Curve 1.

Q. What does that mean, Mr. Douty, with reference to the acid as it leaves the tank, it is going down the pipe in the well, assuming there is no electrical connection or effect from the tank to the pipe in the well? A. It means

that the acid which has been in the Menaul tank for as much as 24 hours is not essentially less corrosive than the acid I put in there in the first place. That once more appears from the comparison of curves No. 1 and 4 of sheet No. 3, Defendant's Exhibit 282, particularly on considering the latter half of curve 4 after the tank had been disconnected. Now, one would expect that at the end of 24 hours acid in such a system would have picked up about as much lead, iron, copper, or any other contaminant as it ever would in any of Defendant's practical tanks.

Now, another indication of the answer to the last question which I just gave, is shown on sheet 6, Defendant's Exhibit 285. In this case, which was run again on hard steel tank No. 1, we have some experiments made both with C. P. acid and with commercial acid to which have been added amounts of iron, lead and copper comparable to those found in the Zahn well, according to plaintiff's evidence. On comparing Curve No. 3, which is the curve for C. P. acid on that chart with Curves No. 1 and 2, which are respectively the curves for C. P. acid to which have been added iron, lead, and copper, or copper alone, we find no essential difference between the rates of corrosion in any of those cases. I would say that all of those curves might well be within the limits of variability of one experiment as shown by curves on previous charts. One curious anomaly is that in curve 4 where lead only has been added to the C. P. acid, the rate of corrosion appears to be considerably lower than curves No. 1 and 2, in which iron, lead and copper and copper alone, respectively, had been added.

Again, I think that the entire range covered by curves 1 to 4, inclusive, is simply a range of uncertainty in this type of testing, one that is to be expected in any type of corrosion testing on this scale. A comparison of curves 5 and 6, which are respectively curves for plain commercial acid and commercial acid containing the three dissolved metals in the proportions stated, shows no essential difference; both might equally have been separate experiments for plain acid or for any one of the acid series we have on

the chart. It is probably significant that the commercial acid in both cases, the curve for commercial acid in both cases, lies below those of the C. P. acid.

One more conclusion can be drawn from Chart No. 3, which is Defendant's Exhibit 282. It is to be noted that Curve 2 represents the rate of corrosion of an acid to which has been added one per cent arsenic trioxide. Am I right, one per cent?

Mr. Hathorn: Yes. A. And it will be noted that the rate of corrosion as shown by those curves is of the same order as the rates of corrosion for the experiments in which commercial acid was put into the tank having a bonded lead plate. Now, those are about all the conclusions that one can draw with certainty from the experiments made with the hard steel tanks, which seem decidedly less variable than those made with the soft steel tanks.

I don't know whether it is worth while to point to the experiments in the charts which represent the results on the soft steel tanks, which support the following conclusions: That the corrosion rates under apparently the same conditions are extremely variable. I think that has been already pretty well demonstrated. However, we might look at Curve 4, Sheet No. 4, rather, in Defendant's Exhibit 283, and compare curves 1 and 2. I should say in this particular example the variation between the rates for commercial acid alone, as represented by curves 1 and 2, is not markedly greater than the variation for the other type of steel. On curve sheet No. 5, Defendant's Exhibit 284, we find a rather tremendous variation between the rates of corrosion experienced by tanks of soft steel immersed, or, rather, containing commercial acid with the tank bonded to a lead plate, and that is rather more of a difference than ever appears on the hard steel tanks. We notice in this exhibit that the lead plate does definitely give some protection, and the same thing is visible in Sheet 4, Defendant's Exhibit 283.

The effects of Tergitol are to give throughout very curious and variable results, which can be seen by compar-

ing on Defendant's Exhibit 283, curves 4 and 6. And it is not entirely the only example. Now, we can find only one other significant--one conclusion that really—that is really valid for the soft steel tanks without any question, and that is that one per cent arsenic trioxide gave good protection in every case it was tried. You see that on sheet 4 and we see it again on sheet 5. Curve 8 on sheet 5 and curve 7 on sheet 4.

Q. Would these soft steel tanks, or these curves for those tests, permit a conclusion that the acid from the Menaul tank, after leaving the tank where the disconnection of the bond between the lead plate and the steel, was less corrosive than the acid which was introduced into the tank? A. No; I hardly think it would permit any such conclusion. I think if there is any conclusion at all, I would say that they were inconclusive on the point, on that point. I am speaking now of the experiments with the soft steel tank, that the normal rate of variation of corrosion for the original acid is so great that one cannot draw any conclusions from the slope of the curves after the disconnection of the lead plate. In fact, in most instances, they lie well within that range of variation.

Q. Would you consider that a criticism of Mr. Hathorn's work, or how does it compare with your own knowledge of what results can be obtained in measuring rates of corrosion on soft steel? A. The more corrodable the steel and the higher the rate of the corrosion, other things being equal, the less accurately the corrosion rate can actually be measured. In other words, for a slightly corrodable substance, metal, one is able to get more reproducible results than for a greatly corrodable substance.

Q. That is because the corrosion is going on in greater magnitude and, therefore, being a variable it increases, it magnifies the variation, the result you get, is that correct? A. That may be one reason; there are probably others that have to do with why metals corrode more rapidly and more slowly, such as the variability of composition within the mass. However, that is a fact that it is particularly

difficult to get check results when substances are present which deposit more or less irregularly upon surfaces during the corrosion.

Q. You are familiar with the report of Dr. Prutton in this case. In your opinion is his conclusion justified from that report in the tests reported by him as to the relative rate of corrosion of the Menaul acid after the bond had been disconnected or after the acid has left the system? A. No, I think that generally speaking Dr. Prutton's results simply fail to establish whether or not there was any electrical effect or not. They simply fail to establish it. In fact, the variation of Dr. Prutton's results among themselves have an order which would have permitted of a considerable degree of electrical protection without Dr. Prutton's method having been sufficiently refined to discover it.

Q. Well, do you think it is possible, based on your knowledge of trying to duplicate test results in measurements of the corrosiveness of hydrochloric acid on soft steel to conduct experiments of the kinds that have been attempted here on both sides which would, with any validity, establish or exclude the presence of an electrical effect assisting in protecting the pipe down the well if the connection is made between the pipe and the tank in the Menaul system? A. I am being asked whether something is possible. I do not like to say it is impossible, but I will say that no method that has been mentioned here, at least carried out as anyone has been able to carry it out here, with the best precautions, has been able to establish that one way or another at all.

Q. Now, you are experienced in this matter of electroplating and electrochemical effects as they affect corrosion, are you not? A. Yes, sir.

Q. That is your business? A. I am not—

Q. (Interposing): What is your view as to whether or not connecting the Menaul tank with the well pipe assists in protecting the pipe from corrosion; on theoretical considerations do you think that such protection should be

provided by that connection or not? A. I know that protection can be afforded a piece of steel by bonding the lead. I know that that protection can extend to a certain distance, and there are theoretical reasons for believing that it may extend to a great distance. I, therefore, see no reason why protection should not be afforded, at least to some extent, to the well pipe by the Menaul connection.

Q. Have we any method of determining, either theoretically or actually, quantitatively, how far that protection would extend? A. I would hesitate to say that we have a method available. I do not think there is a very easy way to find out.

Q. Well, do you know of any method? A. I do not.

CROSS EXAMINATION

By Mr. Owen:

Q. Will you refer to Table 2 on page F of the data sheets which are in evidence as DX-299 and compare your runs A-1 and A-2 with runs D-1 and D-2? A. Yes.

Q. First, state whether I am correct in my understanding that A-1 and A-2 represent blank runs using C. P. acid? A. That is correct.

Q. And D-1 and D-2 represent runs in which steel strips were placed in a lead chloride solution? A. That is right.

Q. What was the strength of that lead chloride solution? A. I don't know exactly—I know it was far stronger than any amount of lead mentioned in this case.

Q. Well, then, compare the average results of runs A-1 and A-2 with the average of D-1 and D-2, and state what you find to be the inhibition shown in the lead chloride runs as compared with the runs using C. P. hydrochloric acid. You used 15 per cent acid, I understand? A. I did. That has already been done, Mr. Owen, on page K of these results.

Q. What do you find to be that per cent? A. I find that if the attack in experiments A as compared with the

attack in experiments D—in experiments D I get about 63 per cent, 62.9 is the figure I have here, 63 per cent as much metal is dissolved in experiment D as in experiment A.

Q. Translating that into terms of inhibition, what would be the inhibition shown in the lead chloride solutions over that of the blanks? A. I presume that the number that Mr. Owen wants is obtained by subtracting 63 per cent from 100 per cent. I can do that, or anybody else can perform that arithmetic.

The Court: You got 63 per cent of what? A. Actually, Your Honor, I found that a certain amount of iron was dissolved in experiment A and a certain amount of iron was dissolved in experiment D, and the amount of iron dissolved in experiment D was 63 per cent of the amount of iron dissolved in experiment A. That means that the amount of iron dissolved in experiment D is 37 per cent less than the amount dissolved in experiment A and I think that is all Mr. Owen wants.

Q. Yes. And the only difference between the two runs was the fact that in the D runs the acid contained lead chloride? A. Yes, sir.

The Court: I don't know. You say the only reason it was was because it contained less chloride? A. Lead chloride.

Mr. Owen: The A runs contained no lead chloride and the D runs contained a saturated solution of lead chloride.

The Court: Yes.

Q. Now, on this page N, run A was the blank. A. Yes.

Q. And what did you use in that, is that C. P. acid? A. Yes. All of these were C. P. acid. This is my second experiment, Your Honor, carried out in the same way as the first, except that it went over a longer period of time.

Q. That test was ninety-six hours? A. Yes, sir.

The Court: That is in the clear acid? A. Run A was with plain acid; yes, sir.

Mr. Owen: And run C had the lead chloride in to the saturation point? A. Yes, sir.

The Court: How long did that first HCl plain blank run? A. I think it was fifteen or sixteen hours. Fifteen hours.

The Court: That is the first one that we have talked about? A. Yes, sir.

The Court: And the saturated was the same fifteen hours? A. Yes, sir. All of the runs in test No. 1 were fifteen hours.

The Court: Yes. And now we have got the same thing only it is— A. (interposing): Run over a period of time of ninety-six hours.

Q. Now, will you state how much more iron was dissolved in run A on page N than was dissolved in run C? A. The way the data originally were prepared, the iron loss in run C was 14.09 grams, and in run A 22.27 grams. Run A was blank C. P. acid, and run C was C. P. acid saturated with lead chloride.

The Court: Then we have got two systems of weights here between their way, and now you are injecting another basis, the percentage basis here.

Mr. Owen: That is all we have been dealing with all through the case, percentage of reduction in corrosiveness, and I am trying to translate these figures into the same terms. A. No.

Mr. Lyon: I have been saying here we have just been comparing the actual amounts, or if you are going to try to make it in percentage, they are taking the reciprocal and figuring how many times as corrosive one acid is as another, compared to something in the patent. It doesn't mean—these percentages don't mean anything.

The Court: I am trying to follow both of you. A. Well, Your Honor, did you put down the actual weights lost in the period of 96 hours?

The Court: No, I didn't get the actual weights lost in the 15 hours even. A. Would you like me to give you those?

The Court: Now, here I have a new set of figures. A. Would you like to have me give you those, or have them in

proportion? Actual loss in the first experiment on the average was by analysis 2.5—there were two runs, one of them lost 2.586 grams and the other one lost 2.907. Now, they are supposed to be duplicates. Now, panel "C," which were the ones that were in the solution containing lead chloride, this is all in test 1, Your Honor. I am referring to page "G," going back again to test 1, I thought I might as well get all the results in the same form.

Q. Well, "C" wasn't in the question regarding page "F"? A. It is "D."

The Court: I think I understand, I will listen instead of trying to keep any notes on it at all, and I will let my ears serve me. A. Going back to page "N," Mr. Owen, the relative amount of iron dissolved with lead chloride and without is 61.4 per cent over a period of 96 hours. Stating it the other way, there is about 39 per cent reduction or less corrosion in the second case than in the first.

Q. (By Mr. Owen): That is less where the lead chloride was present? A. That is right, over the whole period of 96 hours.

Q. Now refer to page "P-2"; what was that test? A. Now, this test is simply the test made exactly the same as the first test, except that instead of comparing with plain acid, acid saturated with lead chloride, I compared with plain acid, acid containing 500 parts per million each of lead and iron and 5 parts per million of copper.

Q. And in that test, "A" was the blank? A. Yes, sir. And "D" was the acid containing the metals. In both cases the specimen was alone in the beaker.

Q. Well, now, will you compare tests "A" and "D" as to their relative corrosiveness? A. Yes, sir. The actual losses in weight in case of "A" was 2.58 grams; in the case of "D" 1.28 grams. That means that in run "D" almost exactly 50 per cent as much iron was dissolved as in the case of run "A."

Q. And now will you compare run "F" with run "A," stating first how "F" differed from "D"? A. Run "F" differed from "D" only by the fact that there was in

the solution along with the iron panel a piece of lead which was not touching the steel, and run "F" the amount of weight lost was 1.08, let's call it, grams, and in that case about 41 per cent as much steel was dissolved as in the case of run "A."

Q. So that putting it the other way about—run "F," with the added chlorides of iron, lead and copper, plus a lead plate which was in the acid, reduced the corrosiveness 59 per cent, is that right? A. It seems to be, yes.

Q. And comparing F and D, the only difference was that F had this loose lead plate in and D did not? A. That is right.

Q. And the difference between those two was about 9% in favor of "F"? That is "F" was less corrosive than "D" by 9%? A. That is right. However, I think if you will refer back to page 6 of my table you will find that the losses in weight do not differ. That is between experiments D and F of the fourth test which you were just referring to, doesn't differ any more than the two individual samples in tests D1 and 2 of the first test. In other words, I would say that difference was entirely within the variation to be expected.

Q. So that you would claim that conducting tests in the manner in which you conducted the ones we have referred to, you can get quick, accurate, reproducible results, do you not? A. Moderately so I can, of course.

Q. Within what per cent would you say? A. Well, that depends on how much attack there is. Generally speaking, I would get more closely agreeing results where there was a lot of some substance which had some restraining effect than where there was less, other conditions being the same.

Q. Then I take it from what you have said this morning that you agree with Dr. Bartell and Dr. Prutton that adding lead chloride to C. P. hydrochloric acid of 15% strength, reduces the corrosiveness of the acid some 40 to 50%, isn't that right?

Mr. Lyon: Now, I object to that on the ground as I

remember Dr. Bartell's testimony, and I believe Dr. Prutton's, they stated the lead chloride alone had no more than 12% value.

Mr. Owen: All right, I will pass that.

Q. You show more protection due to the presence of the lead chloride than they did? A. Yes. It may be due to the fact that I used stronger solutions of lead chloride.

Q. Well, what would you say as to your agreement with them regarding the effect of adding around 5 parts per million of copper, lead and iron to a C. P. hydrochloric acid solution, 15%? A. Well, if you will correct that to mean 500 parts per million each of lead and iron and 5 parts per million of copper I would say that my results give relative rates of attack of about the same order of magnitude as Dr. Bartell has indicated on my particular scale under these conditions.

Q. Have you ever run any tests similar to those run by Mr. Hathorn? A. No.

Q. Have you run any large scale tests on this matter concerning which you have testified this morning? A. No, not with any attempt to measure the amount of dissolved iron. I have run large scale tests in the pickling shop where we put through tons and tons of steel and measured the dissolved iron in the acid.

Q. Now, I call your attention to sheet 1 of Mr. Hathorn's curves, DX-280, and to the fact that according to his testimony those runs were made in the following chronological order (you may write them down if you like) 5, 6, 3, 1, 4, 2. Now, referring to the exhibit, 5 was run with commercial acid plus the lead plate and 6 was run with commercial acid plus a lead plate and Tergitol. Now, in view of that fact, what would be your opinion as to whether or not the walls of the tank were coated with lead at the end of run 6? A. At the end of run 6 I imagine there might still have been some slight specks of lead on the walls, but I can't say because the plate had been disconnected. To what extent that lead had been removed, I wouldn't be able to say.

Q. Well, at the point where the plate was disconnected, what would you say as to the walls having been covered with lead? A. I would say that, on theoretical grounds at least, and on the basis of what I found, there would probably be lead on the walls.

Q. You do not know what effect the continuing of that run for 24 hours without the lead plate connected might have had on the amount of lead on the walls of the tank? A. From the course of the curve, I would suspect that lead was being removed fairly fast.

Q. You referred to run 3 which followed run 6, and which was a commercial acid run, and you find that it shows a lower rate of corrosion than di runs 1 and 2, which came later, and which also were run with commercial acid, with no addition. A. That is true.

Q. Now, what would you say as to the probability of some of the lead accumulated on the walls in runs 5 and 6 having remained on the walls during run 3? A. Merely on the face of the curve, in the order you have given me, that could not be excluded. However, after hearing Mr. Hathorn's testimony as to how he cleaned the tanks, I certainly would not expect much lead to be left.

Q. You do notice that run 3 which followed immediately after 5 and 6 with the lead plate in the acid, run 3 showed quite considerably less corrosiveness than did runs 1 and 2, which came later? A. Yes.

Q. Now, the run numbered 1 on this exhibit was a commercial acid run, and shows a high rate of corrosion? A. Yes, sir.

Q. Run No. 4 followed that, and that was a commercial acid run, plus a lead plate, and it shows considerably higher rate of corrosion than does run No. 5, which is also commercial acid, with a lead plate, isn't that true? A. That is true.

Q. Can you account for that in any way? A. No.

Q. Might it not be accounted for by the fact that the commercial run No. 1, having no lead in the acid, ate up, or dissolved all of the lead from the walls of the tank, so that

when run 4 was run it had no reserve protection, and the only protection it got was from the lead plate which was in the tank in run 4. Would that be a reasonable explanation? A. You are entitled to interpret it that way if you want to. I don't think there is any evidence for it.

Q. Have you any other explanation for it? A. No. I don't think I need any.

Mr. Lyon: I think you ought to make a little more complete answer than that. A. After run 1 came run 2.

Q. (By Mr. Owen): Oh, no.

Mr. Lyon: That is not correct. A. Came run 4.

Mr. Owen: That is right. A. And after run 4, in which, presumably since the rate of corrosion was decidedly lower than run 1 which immediately preceded it, one might presume that the tank had once more gotten coated with lead to whatever extent such treatment coats it with lead. Then it was cleaned in the same way as the tank was cleaned after run 5, and we got run 2, and now run 2 isn't—run 2 followed run 4 just as much as run 3 followed run 5.

Q. Yes. And during run 4 the walls of the tank became covered with lead, did they not? A. I think so.

Q. And then run 2, which immediately followed with commercial acid, showed a considerably lower rate of corrosiveness than did run No. 1. A. No.

Q. Isn't that true? A. I don't think so.

Mr. Lyon: Wait a minute. I want to object to the question because the evidence is that between runs—those two runs, the tank was completely cleaned and the witness hasn't admitted and there is no evidence that there would be any lead remaining on the plate following such a cleaning.

Mr. Owen: Mr. Douty, what is your opinion as to the effectiveness of sulphuric acid in dissolving lead?

Mr. Lyon: Plus the reversing of the polarity and the other things that were done in cleaning the tank.

Mr. Owen: Well, now, Mr. Lyon, I would like to conduct my cross examination.

Mr. Lyon: Well, I don't mean to interfere.

Mr. Owen: But you do.

A. Well, Mr. Lyon, sulphuric acid is fairly resistant—I mean lead is fairly resistant to sulphuric acid when the lead is there in some appreciable amount, and the reason is unquestionably due to the fact that lead sulphate, the product of the reaction, is quite insoluble. Now, from my experiments, on which some doubt could be cast, anyway, I find that the amount of lead that might be deposited is from three to five millionths of an inch, and I certainly don't think that amount of lead would withstand forty-five minutes to an hour as anode in ten per cent boiling sulphuric acid, besides which, at the end, particularly when the surface was scrubbed with a steel wire brush, it was rinsed with more boiling water, and finally washed with fifteen per cent hydrochloric acid, which is a better solvent for lead sulphate than is water or sulphuric acid, so that the final wash with hydrochloric acid would probably have removed, in my opinion, all of the lead sulphate which might have remained as an insoluble precipitate in the tank. I would say that the chance of there being any appreciable amount of lead in the tank is small. I cannot exclude the fact that there might be traces of lead on the walls.

Q. And that that might account for the fact that commercial acid run 3, which followed some of the lead runs, was less corrosive than commercial acid runs Nos. 1 and 2?

Mr. Lyon: I would like to have the record show that the witness pointed to run 3 at a time of twenty-four hours, and I assume from that he is contending that whatever amount of lead the witness has said possibly might be on the plate would still be affecting the commercial acid after twenty-four hours in the commercial acid.

Q. (By Mr. Owen): Well, maybe the witness knows what that means, I don't. A. Well, irrespective of the interpretation, I think that you would be stretching a point to draw any such conclusion as implied in the question without a whole lot of further evidence. I will say that if there had been lead left in small quantities on the tank

wall, which I do not know that that is true, in fact I think it is not, at the beginning of run No. 3 it would have been gradually removed and we would have expected this curve to show an upward trend with time, which it doesn't do, and the reason I assume that is because in general those experiments in which there have been a lead plate connected, which was then disconnected, generally do show an upward trend with time in general after the disconnection.

Q. And you cannot offer any explanation for the differences in the rates of corrosion in runs 1, 2 and 3, can you? A. No, I can't offer any explanation.

Q. Nor can you offer any other explanation for the differences in runs 4, 5 and 6, each of which contained the lead plate? A. Well, I don't know what conclusion to draw about experiment No. 6. The rate of corrosion of that tank over 24 hours was essentially zero. It started out at a value of about 40 ounces per thousand gallons of iron and it ended up at about 56 parts per million, as near as I can read that chart—rather ounces per thousand gallons, as nearly as I can read the chart. Now, it may be the Tergitol had something to do with that, I don't know.

Q. That is, run No. 6, which shows a very low rate of corrosion, was commercial acid plus the lead plate plus Tergitol and it differed from runs Nos. 4 and 5 only in the fact that it contained Tergitol? A. Yes, that is all that appears on the chart.

Q. And that would indicate the Tergitol had an inhibitive effect, would it not? A. No.

Q. What does it indicate? A. If it indicates anything, which is questionable, it would indicate that Tergitol assisted the Menaul action in protection; a totally different story. No evidence that Tergitol by itself has any inhibiting effect.

Q. But the evidence is that when Tergitol is present the inhibiting effect of the lead chloride is increased, is that it? A. No, sir, that hasn't been demonstrated by anything here.

Q. How would you account for the fact that with the Tergitol present the rate of corrosion is so much lower than it was in the two runs when it was absent? A. I don't know, I haven't made any great attempt to account for it; I shouldn't be at all surprised if Halliburton could patent that.

Q. Now will you turn to the second sheet, DX-281. In this sheet the order was 1, 4, 2, 5, 3. Now, in this sheet, run 1, which was the commercial acid run, shows the highest rate of corrosion, does it not? A. Yes, sir.

Q. And run 2, which is commercial acid plus Tergitol, shows a considerably lower rate of corrosion? A. Yes.

Q. And run 4, which has the lead plate in, intervenes between runs 1 and 2?, A. That is correct.

Q. So that the lowered rate of corrosion in run 2 might have resulted from the fact that the tank took on a coating of lead in run 4, is that true? A. No, I don't think that is true; I mean, I do not say it is untrue, but I certainly do not interpret it that way.

Q. It would be true if it were assumed that the tanks were not thoroughly and properly cleaned, would it not? A. Once more I think not; the general course of the curve for run 2 is concave towards the horizontal axis, rather than convex towards the horizontal axis, as you would expect had the tank had a lead coating on it to start with.

Q. Then the only way that you can account for the lowered rate of corrosion in run 2, as compared with run 1, is the presence of Tergitol in run 2? A. That plus the uncertainty in the exact rates of corrosion, or the lack of complete reproducibility.

Q. Now will you turn to sheet 3, in which the order was 1, 4, 5, 2, 3, and will you here compare curve No. 1, using commercial acid, with the dotted portion of curve No. 4, which indicates the rate of corrosion after the lead plate was disconnected and the tank cleaned? A. Yes, sir.

Q. I understood you to testify that from the point where the lead plate was disconnected in curve 4, the curve showed substantially the same rate of corrosiveness as that

in curve 1, using commercial acid? A. Within what I think has already been indicated to be the range of reproducibility I would say that is so.

Q. Well, now, isn't it a fact that if you compare the portions of the curve after the lead plate is disconnected in curve 4, that the corrosiveness in 4 was considerably lower, or substantially lower than that in curve 1? A. Well, it is somewhat lower.

Mr. Lyon: At what point is that?

Q. Take from the 24-hour point the next 20 hours, in both of them, and state what the loss in weight was? A. Well, let's see, taking the first curve No. 4, starting at 24 hours, we go from 19 ounces per thousand gallons up to 159 ounces per thousand gallons, which is a gain of 140 ounces per thousand gallons in 20 hours. Now, do you wish me to compare that for the first 20 hours of curve 1, or with the time from 24 on? I don't know whether that is on the curve or not.

Mr. Hathorn: It is not on the curve.

Q. Take the first 24 hours—the first 24 hours then. A. That starts out with 6; that goes from 6 ounces per thousand gallons to 209 or 203—I think it is 203; roughly about 70 per cent as much corrosion in the hours from 24 to 44, on curve 4, as in the hours from zero to 20 in curve 1.

Q. Well, now, isn't it a fact that the only difference in those two runs in the period you have used for comparison was that commercial acid run No. 1 wasn't preceded by a lead plate run and that the portion of run No. 4 which you have considered was preceded by a lead plate run? A. That is correct. That was the object of the experiment.

Q. Can you account for the lowered rate of corrosion in any other way than being due to the fact that the acid contained dissolved metals in run No. 4 after the plate was disconnected? A. I cannot account for it by any mechanism that I can tell you about but if you turn back to sheet 1 and make the same computation—theoretically the tank should be clean at that point because after the cleaning operation it should be clean.

The Court: It was disconnected at that point? A. Then the tank was all cleaned out, the acid poured back into it again.

The Court: As I understand, the point there was he was saying how nearly was this (indicating) parallel with your commercial acid from that time on. A. I say this is about 70% of the slope of that (indicating).

The Court: And now he is asking you if the difference between that isn't due to what was in the acid, and you are answering this was within the range. A. That is correct, and I wanted to prove that by reference to the first chart in which we had two identical runs.

Mr. Owen: Now, referring to curves 3, 4 and 5 of sheet No. 4, DX-283, isn't it a fact that they show practically no break at the point when the lead plates were disconnected? A. That is correct.

Q. They continue right on just as though the lead plate had not been disconnected? A. That is correct. And a curious thing is curve 6 shows a sharp break which should be an identical one with curve No. 4.

Q. Now, turn to sheet No. 5. In this sheet, curves 5, 6 and 7 show no break in slope when the lead plate was disconnected? A. I think you are mistaken about that, Mr. Owen. I think you will find a considerable change of slope in curve 6, for instance, between the early and late parts. I haven't computed what the amount is, but I think it is obvious that the curve has a higher slope. A little hard to see on a curve already so steep, but I think anyone can see, neglecting that slight loop at the end of twenty-four hours and continuing on, that this slope is getting higher and higher, faster and faster, as compared with the lower part of that curve. I think anybody can see that without having it calculated. I may have made some calculation on that. I will see.

Q. Now on sheet 6, this represents runs in hard steel tank No. 1, with copper, lead and iron added to commercial acid? A. Yes, sir.

Q. As I recall, when you referred to this sheet before

on direct you stated that you couldn't make any sense out of the curves on this sheet, is that right? A. That is right.

Q. You can't account for them? A. No.

Q. Well, neither can we. A. All I think I said before was that this group of curves, for instance 1, 2 and 3, is that they might be singularly good members of a series that were supposed to be duplicates, where they are not supposed to be duplicates.

The Court: While you are on a different subject, which is one which doesn't show practically anything, I want to ask you, Mr. Owen, are you through with showing from these sheets the curves that you wanted to call to my attention for which you claim that subsequent experiments did not show as great corrosion for the reason, as I take it, you claim they were not thoroughly cleaned. Well, they might be either way, one way, and his theory is that there was a tolerance or range within which one group fell and another lower range within which the other fell, and while they varied a lot there still was enough, and I have got to watch that in the same way again too, but these experiments, some of them, I want a hundred before I reach a conclusion about them, to tell you the fact about it. They are that kind of experiments.

Mr. Owen: And these tests of Mr. Hathorn, there are comparatively few runs under the same conditions, Your Honor. There was no attempt to run two or three of the same kind and take an average.

The Court: Someone tell me how many there are here where the subsequent run went higher than the first one after the cleaning; can somebody tell me that? A. Well, Your Honor, would you mind rephrasing that; I mean do you mean to say—

The Court: Well, now, Mr. Owen has shown here that your first run went higher than your second run, and I take it by his questions that he is inclined to think that the tank wasn't thoroughly cleaned, had lead on the wall of it, and that is the reason why the second run didn't get as high. Now, if you find some of these that go the other way, why,

I think that would be very important for me to know, and I haven't any idea about it. I just followed him. A. If I may answer that, Your Honor, I think Mr. Owen's point was this, and if I am wrong Mr. Owen will call me for it. The first run on this sheet No. 1 was No. 5, which was a run with a lead plate in. And that was followed by run 6, another one with a lead plate in the tank. Remember, of course, that the tank was cleaned after each run as well as we know how, as well as Mr. Hathorn knew how. Then after run 6 came run 3. Now, after run 3, which was plain acid, no lead plate, Mr. Owen says, "Now, that one probably represented a nice cleaning operation, merely leaving that acid in there for 48 hours." However, it was all cleaned out over again by the usual method, and then came run 1, Mr. Owen says, "Why did run 1 go so much higher than run 3?"

The Court: Run 1 is just because it is the highest there.

Mr. Allen Owen: It is commercial acid.

The Court: But it was made the last one? A. Yes, of that series, as far as we have gone. In other words, Mr. Owen says that the reason probably that run 3 is lower than run 1 is because it probably had residues of lead from the first two experiments with the lead plate. And he says that is demonstrated by the fact that the next run jumped up a whole lot, and I say it does not prove it at all, because run 2 comes down again; now, I don't know where we are.

Mr. Allen Owen: Run 2 comes down again, Your Honor, because it is subsequent to their lead plate run, which is run 4.

A. Of course run 2 is higher for the first four hours and lower here (indicating), it is hard to say—

The Court: In this talk to me about time now, kinds of runs there, are there any there that the later run is lower.

Mr. Owen: That is where a commercial run followed a lead run, is that what you mean?

Mr. Lyon: Put it this way: is there any there that show the opposite effect of what Mr. Owen pointed out?

Mr. Owen: Yes.

The Court: His contention is that cleaning wasn't complete and therefore the subsequent run wasn't as high as it would be?

Mr. Owen: That is right.

The Court: Now, are there any there that go down? I haven't any notion about it at all. A. I will see if I can find them, Your Honor. Do you mind if I consult Mr. Hathorn?

The Court: Yes, both of you look at it, all of you look at it.

Mr. Owen: Put the order on sheet 4.

Mr. Hathorn: 3, 1, 6, 4, 7, 5, 2.

Mr. Owen: We have got mixed up on our order here. I have one order, and Mr. Hathorn has another.

The Court: That kind of restores my loss of egotism. I got almost an inferiority complex here, and had it until I hear the rest of you tell me about some of your troubles, and that kind of restores me.

(Counsel, the witness and others conferred at the chart board.)

The Court: This is a necessary parley, and you haven't proved anything without this. If you come through there and prove something, then I have another question to ask you, just as soon as you make this riveted quite strong—then I am going to ask you another question.

A. In this particular chart, No. 5, the experiments were run in the order of 4, which is plain commercial acid. This was the first one run (indicating) 4. After that came a lead plate, 5, which had a lead plate in it. Then came No. 2, which is up here (indicating). Then came No. 3. That had a lead plate, and also Tergitol. Then it went to No. 1, which did not have the lead plate or the Tergitol. So when this—in this particular instance, the subsequent runs were higher instead of lower (indicating).

The Court: Which is the first one? A. No. 4.

The Court: The lowest one here, of the plain commercial acid, that is the lowest one, isn't it? A. Yes.

The Court: What does this do to your theory, Mr. Owen?

Mr. Owen: This is the sheet that Mr. Douty said he couldn't make anything out of, and we said we couldn't either.

Mr. Allen Owen: This one shows no electrical effect in the run which was supposed to have leaded up the tank. That is the only one that Mr. Douty will agree there is no change in the slope? A. I cannot see any break at all there. It looks to me as though that is a general kind of curve there, though (indicating).

Mr. Allen Owen: There is very little if anything left on the side of the tank.

Mr. Hathorn: The lead plate reduced the corrosion, though.

Mr. Allen Owen: I grant you that.

The Court: Doesn't this one disturb your theory, or tend to; in other words, if that were just reversed, you would be citing it to me as another good example (indicating). The next question I was going to ask you, Mr. Owen, was, I take it that this agrees with your theory, but we will suppose it does not, if you had some uniformity—every time the second run went lower, then the results that you claim from that would be that the wall had been coated by the lead plate, which was connected up to the iron in such a way that it prevented corrosion to a certain extent. My next step is, to the extent that it does that, that is without putting any inhibitor fluid that they use, isn't it, to the extent it does that?

Mr. Allen Owen: All we claim for those things is to show the more or less faulty technique that Hathorn used, because his results are entirely unpredictable.

The Court: I say, that would follow right along, that independent of what is in the solution, a lead plate connected to the iron does give protection to the iron?

Mr. Allen Owen: There is no question about that.

The Court: The thing the argument is about is whether by giving that kind of protection it also leaves

some of the lead in solution, which, as lead in solution, gives an added protection too.

Mr. Owen: That is true.

The Court: Now, is there any dispute of that by the other side?

The Witness: I dispute it, Your Honor. And I think I have a report in my evidence to prove it.

The Court: You say it didn't result from that? A. Yes, sir.

The Court: But the main thing resulted from the lead connected with the iron? A. That is right.

Mr. Allen Owen: I don't think Mr. Douty disputes that after you take that acid out of the tank containing dissolved lead and then put a steel strip in there, I don't think Mr. Douty will deny the acid was less corrosive than before the lead was put in. A. To the extent the lead could act as a resistance, it would. We cannot deny that.

The Court: That is independent of the other, the electrical action? A. Entirely apart from that. The way I am informed, the defendant sets up a truck tank, puts acid in it, and when they get to the well, they dump it down the well. I have never been down a well, I never made a test on the well, Your Honor. So far as their own truck tanks go, this was done in a laboratory test, never done in actual practice. I claim Halliburton's protection in the truck tank is independent of whether anything goes into the acid or not.

The Court: You claim the lead plate connected with the iron while it is there and so connected gives a protection to the iron in addition to what is in solution? A. No, sir, a protection in the iron which is not improved but, according to my experiments, actually is impaired by any lead in solution.

The Court: But you do claim that lead plate connected with the iron is giving protection to the iron of the tank independent of whether there is any lead in solution in the acid or not? A. That is right.

The Court: That is their claim and you don't deny that, as I understand it?

Mr. Owen: Our contention is somewhat different from Mr. Douty's. We claim the main protection is from the lead chloride in solution and that the connecting of the lead plate may add something to it, and I think, as I understand—

The Court (interrupting): And if I had succeeded in this of showing that they were all that way, and convinced that always in the second one would add so much lead on by the first they didn't get it all off by this, would be just additional proof of that thing. Of course you were attempting to prove another thing but by doing that you would be proving the extent to which this lead plate connected with the iron did put a coating on the iron which protected it, which you are not complaining about under your patent and have no right to claim anything.

Mr. Owen: No. What we claim is that the lead, copper and iron which are in solution in the acid when it leaves the defendant's truck tank are the effective inhibitors in defendant's process.

The Court: Well, all right. But I think this proof brought out in the discussion does help to analyze this problem.

Mr. Owen: Now, I have just one more sheet of these drawings that I would like to ask Mr. Douty about.

The Court: I think it is very proper, and helpful, this discussion—we can't tell who it will help—but it does help in the understanding about it.

Mr. Owen: Now on sheet 7 will you compare curve No. 1 which is the C. P. acid run with Curve No. 5 which is a C. P. acid plus lead, iron and copper run at 10 hours, and point out what the amount of iron dissolved in each of those was at that point? A. Well, the C. P. acid containing lead, iron and copper, according to this test, at ten hours contained 210 ounces per thousand gallons of iron, and the plain C. P. acid contained 462. 210 and 462 are the two numbers. The blank is negligible in this particular run.

Q. Now, what is the difference in corrosiveness of those two solutions? A. Well, apparently, as expressed by the two numbers, which I have just read, 210 and 462.

Q. And would that show that the acid containing the copper, lead and iron chlorides is about 54 per cent less corrosive than the one without those metals? A. That sounds about right. However, I also call to your attention curve No. 3 in which a commercial acid containing no added metals whatsoever is also far less corrosive than the C. P. acid.

Q. Now, will you compare that curve No. 3, which is commercial acid, with curve No. 6, which is commercial acid plus iron, lead and copper? A. Commercial acid containing the lead and copper at ten hours dissolved enough iron to give an iron concentration of 151 ounces per thousand gallons, and for the plain commercial acid the number was 250.

Q. What reduction in corrosiveness does that show for the acid which contains the metals? A. Oh, roughly forty per cent.

The Court: Let me understand, and let me know clearly now whether or not that one where we found a reversal of the situation, namely, where the test with the clear acid without any lead having been previously used was more than that after the lead had been used, and the plate was cleaned, the reversal of it, was it on that sheet that both sides have said couldn't be made use of, or was it the other?

Mr. Owen: I think it was another sheet.

The Court: I want to get that clear. Which one was it on? A. In justice to these curves, I must say that one of those sheets out of which I said it is difficult to draw conclusions was the sheet No. 7 here, from which Mr. Owen has just asked me to draw a conclusion.

The Court: Which went the other way. A. Surely.

The Court: I know it. But I want to make it clear that here is one with decidedly the opposite results that nobody has contended for that purpose. A. That is right.

Mr. Owen: I believe I asked you a question as to what inhibitors or acid regulators or pickle control substances the American Paint and Chemical Company were manufac-

turing when you went with them? A. I have been thinking that question over during recess and I recall that when I became connected with the American Chemical Paint Company Mr. Gravell had tested a number of things and had finally found that bone tar oil, mixed with sulphuric acid, gave a product which was a reasonably efficient pickle control substance, and that is about as far as he had gone. Whether any of that had been used commercially at the time I joined the company, I don't remember, but some of it was used commercially shortly thereafter, I am sure.

Q. And that would be the first one, at any rate? A. Yes, sir.

Q. Will you tell us what that was, how it was made? A. I don't remember the proportions, and I haven't the formula with me, but it was made out of concentrated sulphuric acid and bone tar oil. It was a very unpleasant material to make and unpleasant material to handle, an evil odor. It was called "Rodine."

Q. Well, what is the name and formula of the first product your company made and sold as a pickle control substance or acid regulator? A. The first one I can find in the formulas of the company, and, therefore, it is the first one that I am sure that was used commercially, is known as "Rodine extract," and appears in our formula book as formula No. 71, under date of December 1, 1923. Now, I have reason to believe that there was an earlier formula for that, which probably didn't get into this formula book, because I find immediately preceding formula 71, a formula, No. 70, of the same date, which refers to "Rodine extract." However, since they were written on the same date, I am not sure that it wasn't referring to the same product.

Q. Which of them was manufactured and sold? A. Rodine extract was certainly manufactured and sold.

Q. What is the formula of the product that was manufactured and sold? A. The formula is very similar to the formula given in the Gravell patent in suit, at the top of the first column of the second page, except that it does not contain any arsenic.

Q. Well, then, it would be the formula which appears at the bottom of the first page, wouldn't it? A. Yes, that is very close to it.

Q. I wish you would explain just how that product was made. A. I will read the formula sheet here. It has directions. At the top of the formula sheet it says, "Tar oil," which means bone tar oil, ".476 gallons. Hydrochloric acid, .727 gallons." Mr. Gravell has here in parentheses after hydrochloric acid "1.200," but I know that we never had any commercial hydrochloric acid of that gravity, and he must mean 1.160, which is the gravity of 20 degree muriatic acid. We never had any 22 degree muriatic acid in the place. So that is really about 31 per cent hydrochloric acid. The official table of specific gravity of hydrochloric acid solutions, adopted by the Manufacturing Chemists Association, gives for 1.200—that would be 24.2 degrees Baume. Well, now, there isn't any such hydrochloric acid commercially. The strongest one we have ever had in the plant would have a gravity of 1.160, which is 20 degrees muriatic acid, and that was what was actually used, and that is 31.45 per cent HCl.

The Court: And there was .727 gallons of it? A. That is right, sir, of 20 degree Baume.

Q. Now, assuming that that formula called for 20° Baume hydrochloric acid, what was the proportion appearing of hydrochloric acid in the product? A. The total hydrochloric acid in the product would have been something like 20, 23, to 24%. But, of course, some of that hydrochloric acid would have existed there as salts of the basic materials in the tar oil.

Q. How much do you assume would have been consumed in neutralizing those salts or neutralizing the basic material in the tar oil? A. The tar oil consisted of approximately one-half basic material. That would have meant that there would be about 200 grams of tar oil bases per liter of product and the average molecular weight of those bases would have been somewhere in the neighborhood of 300. Therefore, about two-thirds normal hydro-

chloric acid would have been sufficient to neutralize them and the acid actually used was approximately 7.3 normal. So that I should say about 85 to 90% of the hydrochloric acid I have mentioned would still have remained free. So there would probably have been somewhere between 15 and 20% of free hydrochloric acid in the product.

Q. Now, will you explain the process of making this product which is shown in the formula at the bottom of page 1 of the patent and just explain it in some detail, please? A. I will read the directions on the formula sheet, written in Mr. Gravell's style of typewriting—"The tar oil is first placed in the agitator and the hydrochloric acid while stirring. Considerable heat will be generated. The agitator should be covered and connected to a chimney to take care of the vapors evolved. The agitation should be maintained for approximately 1 hour, and then the admixture should be allowed to settle for twelve hours when it will be found that it has separated into two layers, with a contraction in volume of .013 gallons. The bottom layer consists of Rodine extract and will measure 1.00 gallon in volume, and the top layer will consist of oil and will measure .19 gallons in volume, as shown in the following table," and the figures are retabulated showing the loss in volume and oil separated.

Q. And what is the pickle control? A. The bottom layer is Rodine extract.

Q. And what proportion is that of the whole? A. About a little over eighty per cent.

Q. Then the product that was actually shipped was this bottom layer with the hydrochloric acid that had been taken up in the process of manufacture; is that right? A. Yes. All the hydrochloric acid remained in the bottom layer.

Q. And what was the purpose of using the hydrochloric acid in connection with that bone oil extract, or that bone oil, rather? A. To extract the basic materials from the bone oil, which basic materials were the active inhibiting ingredient, and hold it in solution. There was

also a secondary effect which is not particularly important here, except that it is a curious fact that small amounts of hydrochloric acid have an inhibiting effect when added to sulphuric acid, so that there was a deliberate use of an excessive hydrochloric acid here because it increased the inhibiting effectiveness of the material.

The Court: And by that you mean inhibiting as to eating iron? Reacting with iron? A. That is right, sir.

The Court: Hydrochloric acid on sulphuric. Sulphuric itself is corrosive. A. Yes.

The Court: And will react with iron, but you put in a little bit of hydrochloric, which in itself and alone will eat iron and that combination is less corrosive than either one of them? A. That is correct. I found a reference to that in some of the journals I have read in preparation for this case. In fact, in some of the references which the plaintiff has cited.

The Court: In other words, they find in themselves some satisfaction that is exhausted for their reaction with iron; they take it out on each other. A. Apparently.

Mr. Owen: That product you say was called Rodine? A. Rodine extract.

Q. And it was sold and used in what way, for what purpose? A. The only purpose that I remember Rodine extract ever having been used for is as an adjunct to the pickling of steel articles.

Q. It was put in the pickling bath? A. Yes, in small proportion, of the order of one-half to one per cent of the concentrated sulphuric acid, which was a constituent of the pickling bath.

Q. How was it shipped? A. In glass carboys.

Q. Now, what other similar product, if any, was made and sold by the American Chemical Paint Company shortly after you went with them? A. The next product that appears in the book was Rodine No. 3, which bore our formula number 85 and the date June 18, 1924. And that consisted of a material very similar to the previously named material, except that an effort was made to remove

a certain amount of tarry substance that was likewise dissolved by the concentrated sulphuric acid from the tar oil, and which was objectionable in the pickling operation because it had a tendency to leave spots and deposit on the pickled metal.

Q. Was it made in the same way as the other Rodine you have previously referred to? A. The final proportions were essentially the same, but the method of manufacture was a little different in that the extract was first made as before and separated from the waste oil and then the extract was treated with alkali so as to throw out the free bases, and the free bases were redissolved—or, rather, let me put it this way: the extract was made which was somewhat more dilute than previously made, so that it wouldn't take up so much tar and then the bases were liberated from the extract and redissolved in hydrochloric acid in essentially the same proportion as before, so as to have a material that made a nice clean water solution without tar to go in the pickling bath.

Q. And was the final product about the same, you say? A. Yes, very nearly.

Q. Same proportion of hydrochloric acid? A. Yes, it had, I see by the book, .753 gallons of hydrochloric acid in a gallon of finished product, whereas the other one had .727. It had a trifle more hydrochloric acid in the finished product. It worked the same as before.

Q. What was the number of the next formula? A. The formula that I just read to you, Formula No. 85, has a notation on the top of the page, in Mr. Gravell's handwriting, "Discarded, see Formula No. 92."

Q. That is, the one that you have just referred to, was discarded? A. Yes. You can see here, we have, curiously enough, Formula No. 90, and this is also marked discarded for Formula No. 92. Formula 90 appears on October 29, 1924, and Formula No. 92 is on November 12, 1924; so that the material of Formula No. 90 apparently was short-lived in our formula book, and was immediately replaced by the November 12, 1924, material, and that is

the material Formula 92 on which Mr. Gravell has written "Standard."

Q. How was that made? That is, how did it differ from the other? A. May I state that before Formula No. 92 became standard, the October 29th Formula No. 90 was made exactly the same as Formula No. 85, except that a solution of arsenous oxide was added to it, and that was also added in the case of Formula No. 92, which is the standard material of November 12, 1924.

The Court: From what you have given me, I have the notion that 85, and 90, were probably in their day standard, and that this pencil mark simply is the result of some day, we don't know just when, he just marked that, as the standard? A. Very likely, Your Honor, he was revising his formula book on that day, and he went through these formulas and said, these are discarded, and this one is the standard one, on that date, whenever it was.

Mr. Owen: Now, going on with your products, what was the next product put out, or that you say will comply with the formula at the top of page 2 of the Gravell patent? A. The next product which would approximately correspond to the formula at the top of page 2 of the patent was Rodine No. 2, treated, our Formula No. 105, of date April 6, 1925.

Q. What were these other earlier Rodines called by number? A. No. 3 preceded No. 2. Formula 92 was No. 3 Rodine and Formula 90 was No. 2 Rodine, and Formula 85 was Rodine extract; no, that was also Rodine No. 3. That goes all the way back to the first one I gave you to get Rodine extract, that is 71.

Q. How did this Rodine No. 2 differ from No. 3? A. It appears to be very nearly identical with it. For instance—(after examining document)—oh, I wish to make one correction in my previous testimony. I overlooked the fact that in Formula No. 90, .508 gallons of bone tar oil was used to make a gallon of finished product. In Formula No. 92, only .320 gallons was used. In other words, that was somewhat weakened for some commercial reason or

other. I do not think that Rodine No. 3 was sold over a very long period, because I see there on April 6, 1925, we had a formula for Rodine No. 2 in which once again almost a half a gallon, namely, .496 gallons of bone tar oil was used for making a gallon of finished product. So we seem to have restored the strength again, and made it under Rodine No. 2.

Q. It is your opinion that Rodine No. 3 was not sold very much? A. Well, it probably was not sold much beyond the early part of 1925. I did not mean to imply that there was not much of it sold there. I meant simply to say that it may have been extensively sold during that period, but the period during which it was sold at all was not very long. I cannot give you any figures at all as to the sales of this material, Mr. Owen.

Q. You don't know whether it was extensively sold, or only slightly? A. I cannot tell you. I have not got any sales figures.

Q. Well, then, your No. 2, appeared when? A. April 6, 1925. Now, it is curious that formula 105 which appeared on that date has Rodine No. 2 and then, in parenthesis, treated. There is nothing in the formula books here to tell me but I am almost certain that what they meant was that what was in this book as Rodine extract was for a very short time known in the company as Rodine No. 2, and this Rodine No. 2 which is marked treated, is the one which superseded that. Therefore, since we had never had an official Rodine No. 2 in the book we now started over again with Rodine No. 2, which is really subsequent to Rodine No. 3.

Q. And when did Rodine No. 2 disappear? A. Rodine No. 2, I don't think has disappeared yet. Rodine No. 3 disappeared.

Q. Referring to the formula at the top of page 2 of the Gravell patent, first column, has your company ever made and sold a similar solution using a metal other than arsenic? A. No. Not unless you include gelatin among the organic bases, and there is some doubt about that.

Gelatin was used in a material that we made which included gelatin and stannous chloride. I think it was Rodine No. 6. It was used in pickling baths. Sulphuric acid pickling baths, largely.

Q. What is the nearest thing you have manufactured and sold, that is, the nearest to this formula at the top of page 2 in which a metal other than arsenic was used? A. It is pretty hard to say what is the nearest thing. We sold the mixture I referred to which contained tin as a solid, as I recall. At a considerably later date, we sold the material called Murodine. That would be somewhere in probably 1935.

Q. And how did that differ from your Rodine No. 2, for instance? A. That was based on the patent of Saukitis if I am not mistaken, patented some time in 1937 or '38, and it was for a combination of copper with certain organic materials as an inhibitor in hydrochloric acid. That was 1936. The Saukaitis patent is dated August 4, 1936, No. 2,049,517.

Q. What was the formula under which Muridine was made? A. I prefer not to give you the formula in detail, but it contained copper chloride and certain complicated organic bases made by reacting aldehydes with amines.

Q. Did it have any hydrochloric acid in it? A. Yes.

Q. You gave the formula in your deposition, did you not? A. I think I did, or at least I gave you certain parts of it.

Q. I call your attention to your testimony on page 107 of the depositions taken in January, 1941, and ask you to look that over, and the subsequent pages, and see if you can give the formula for Murodine? A. Well, according to the deposition,—and I was reading from the formula at the time I testified—Murodine No. 101 is the one I am speaking of—it contains about fifty per cent by weight of a complicated reaction product of aldehydes and amines, and another active ingredient of an organic nature which I have here forgotten, and some copper chloride, and you asked me at that time, Mr. Owen, how much hydrochloric

acid was in the final product and I stated from the formula it was very close to eighteen per cent by volume of twenty degree acid, which would make it run about, say, five or six per cent of hydrochloric acid,—of hydrogen chloride.

Q. How much copper chloride was in that? A. About six-tenths of a pound per gallon, that is six-tenths of a pound of copper chloride dihydrate.

Q. How does that amount of copper chloride compare with the amount of arsenic trioxide in the formula at the top of page 2? A. The formula at the top of page 2 contains .125 pounds of arsenic trioxide and this contains .60 pounds of cupric chloride dihydrate. The arsenic computed as metal in the formula of the Gravell patent at the top of page 2 is .085 pounds in a gallon. Now, the copper in Murodine No. 101 is .226 pounds of copper per gallon.

The Court: The arsenic is less than the copper? A. Yes, sir.

Mr. Owen: Do you consider that this formula for Murodine 101 is substantially the same as that at the top of page 2, column 1, of the patent, except for the substitution of copper chloride for arsenic trioxide? A. It has a rough resemblance; I should say it is somewhat similar. The object of the copper in that formula, however, is not to make the material shipable in steel. We want the copper in there when the customer gets the material.

Q. Does the presence of the copper in Murodine 101 make it shipable in steel? A. Yes.

Q. Do you ship it in steel? A. No.

Q. How do you ship it? A. Glass or wood.

The Court: What is the purpose for your customer's use? A. That was designed for use in oil wells.

Mr. Owen: I am going to ask what your customers use Murodine for? A. It has been used in a number of applications, notably the cleaning of steel equipment which has lime scale on it, by means of hydrochloric acid. We sell hydrochloric acid which contains a certain percentage of Murodine as a material called chlorodine, which is used for cleaning out automobile radiators, boilers, and things of

that kind, but we had hoped to sell the largest amount of that stuff in the oil well treating industry, and we did sell some for quite a while.

Q. And you did sell some of it to The Dow Chemical Company, did you not? A. Yes, sir.

Q. And you shipped it to them in wooden barrels? A. That is right.

Q. You also sold some of it to the Halliburton Oil Well Cementing Company, didn't you? A. I am not sure about the Halliburton Company, Mr. Owen. I don't know whether we sold them Murodine or didn't. Mr. Spruance may have said we did. I don't know. I know we sold to the Dow.

The Court: As I understand it, if this patent of defendant's is any good, you have been infringing that if you shipped it to Dow in steel containers? If their patent is good? A. It is our patent, Your Honor, so we never gave any worry about that.

The Court: Oh, it's your patent. That is right. A. It used to be our patent until we sold it to Halliburton a few years ago. I think we have a license from Halliburton to use it in our own business.

Mr. Owen: Now, have you ever manufactured and sold any product other than Rodine and Murodine which corresponded to the formula at the top of page 2, with the exception of the metal used? A. No, I think not.

Q. Now, among the products which you have thus far named, which have had the largest sale? A. In gallons, Deoxidine. I don't know about the dollars. But the Rodine and Deoxidine have been the largest selling materials made or shipped under the Gravell invention.

Q. And the Deoxylyte has been a small seller? A. Not small, but it has been decidedly less than the other two.

Q. And the Murodines, where do they stand in the scale of volume? A. Murodines have been comparatively small sellers, and about the time we were about establishing a nice business in that respect, Dow stopped us.

The Court: By this suit, you mean? A. Well, by writing us a letter warning us not to sell the materials for use

in oil wells, and warning us of the existence of their patent and so we tried to sell the inhibitor to Dow and did so for a while, and then they ceased to purchase from us and that was the last time we supplied inhibitors for oil wells.

Q. Do you recall whether in that letter the Dow Company told you you could sell to their licensees as well as to them? A. I don't, Mr. Owen. No, I don't. I have the letter. I have seen it. But I don't remember that.

Q. So that your sales of products which you understand to come within the Gravell patent have consisted of Rodines, Murodines, Deoxidine and Deoxylyte, is that correct? A. There are two other minor products, one of them known as Murodine—no—Clorodine, which is hydrochloric acid to which has been added substances, including arsenic, plus arsenic; and then that other material to which I made reference a little while earlier, Scalolene, which is used, which was used for a while in removing contamination from glass molds.

Q. Well, all of these products which you have made and sold under the patent have been products which contain acid as one ingredient of the product, is that right? A. Yes, sir.

Q. And in the phosphoric acid solutions—that is Deoxidine, Deoxylyte, the percentage of phosphoric acid is high, is that right? A. Yes, sir.

Q. And in the others, the Rodines and Murodines, the percentage of acid is low? A. Relatively.

Q. Well, it is down around 15 or 20% isn't it, of the solution? A. Well, not these Rodines, it isn't.

Q. How much hydrochloric is contained in your Rodines, your Murodines, or any other products made under the patent? A. Well, I have already given you the figures on several products. Rodine No. 2, which corresponds very closely to the material at the top of the column I think I calculated this morning that that would have had between 15 and 20% hydrochloric acid in it. That is of hydrogen chloride.

Q. You never have undertaken to ship acids for gen-

eral use as acids under this patent, have you? A. Only one acid. Phosphoric acid.

Q. And that is this Deoxidine and Deoxylyte? A. We have called that Deoxylyte and have shipped it as inhibited phosphoric acid for several special purposes.

Q. Is that used for some purpose similar to the Parker process or any of them? A. No, these inhibitors are very deleterious in a process like that. They interfere with the action that is necessary to get your rust proofing on the steel.

Q. None of your products are shipped as acids, are they? A. No. They are not just shipped as hydrochloric acid, sulphuric or phosphoric acid.

Q. I show you an exhibit which was identified in connection with Mr. Spruance's testimony as Spruance Exhibit 7, and ask you if that is the label you place on these products when they are shipped? (Handing same to witness.) A. If Mr. Spruance said so, it is. That is an official label. The regulations of the I. C. C. require you to place such a white label on certain products.

Mr. Lyon: I was going to ask Mr. Owen that Mr. Spruance's deposition be received in evidence with all its exhibits, but ask it be considered read. I didn't think there was any special point in reading it, taking up time to read it.

Mr. Owen: That is agreeable to me. Either party can refer to it as they like.

The Court : Have you the letter here? A. I don't know exactly the answer to your question, Your Honor, but I have a letter here which gives me some dates. The first sale of Murodine made by the Thompson-Haywood Company of—Haywood Chemical Company, of Tulsa, Oklahoma, to Dowell, is reported here as being made in 1935, but sales may have been made earlier than that.

The Court: When did you quit? A. We quit selling to Dow in 1937, January 16th.

The Court: Well, but did you quit selling to anybody? A. No, sir, we still sell Murodine in comparatively small

quantities for use in cleaning out water jackets of engines and radiators and boilers.

The Court: You quit for wells, did you, at that time? A. That is right, sir.

The Court: What amount of business was that, about, that you stopped, can you tell me? A. I haven't any idea, but I think it will appear in Mr. Spruance's deposition.

Mr. Owen: In shipping these products you have referred to, are they sealed or unsealed during the shipping operation? A. Sealed.

Q. Do you store them in stock? A. Yes, we store them. Not usually tightly sealed. We usually leave the bung loose when they are standing out in the hot sun which they generally are; they are generally stored in a yard.

Q. If you store them inside, you tighten the bung down? A. Ordinarily.

Q. Now, I show you three labels which were produced and identified in connection with your deposition, one of these marked Plaintiff's Douty Exhibit 1, and another Plaintiff's Douty Exhibit 2. Those are both Murodine labels, No. 101. Can you tell what the difference between those labels is? Why the two of them have different dates or what— A. Yes, the first one was printed in 1934 and the other one in 1940, to start with. In 1934 we had only one patent on there, namely a patent to a man named Chamberlin, I think, which we own. That patent was the only patent we had on the material at the time. It says on there "Other Patents Pending." It turned out that I found another patent that should have been on that label, which wasn't another patent of Chamberlin's. Then, in addition, it bears the Saukaitis patent number.

Mr. Owen: I will offer the earliest Murodine label as PX-306.

(Whereupon the label was marked PX-306.)

Mr. Owen: Now look at this Exhibit 306 and read into the record the patent number or numbers appearing thereon. A. It says Patent U. S. A. 1,719,649 Other Patents Pending. That is a patent to Chamberlin.

The Court: That was a formula patent? A. Yes, a patent for a certain kind of an inhibitor.

The Court: The ingredients that went into it? A. Yes. A certain type of reaction process it was.

Mr. Owen: That was a process patent? A. I am not sure. I don't think so. I am only testifying from memory. You have all the patents.

Mr. Owen: I offer the later Murodine label as PX-307.

(Whereupon the label was marked PX-307.)

Q. Please read into the record the patent numbers appearing on this PX-307 and state who the patentees are and what they refer to. A. U. S. Patent 2,049,517—that would be Saukaitis patent. The next one—Patent Canada 1937—and that is doubtless the Canadian patent corresponding to the Saukaitis U. S. patent. And then it says For Use in the Processes or Solutions of the following patents—U. S. numbers 1,719,168 and 1,719,649. Those are both Chamberlin patents.

Q. You don't find the Gravell patent in suit on either of those labels, do you? A. No, sir.

Mr. Owen: I have another label here for Rodine, which I will have marked PX-308.

(The label referred to was thereupon marked PX-308.)

Q. Will you read into the record the patent numbers appearing on that label, and state what they cover? A. This label is for material known as Rodine. It was Rodine liquid No. 102 for muriatic acid. That material did not retain the name "Rodine" No. 102 very long. It is now known as Murodine 102, and it consists of a solution of organic inhibitor. It is not acid, and, therefore, it could not have the Gravell number on it. However, it is Chamberlin's patent number, U. S. Patent 1,719,168. It also says, "Other patents pending."

Q. Do I understand from your last answer that you consider the Gravell patent to cover only acid solutions? A. Certainly, materials for use in acid solutions, such as the composition described in claim 7.

Q. The Gravell patent does contain several compositions of matter claims, numbers 5 to 8? A. Yes.

Mr. Owen: How long, in your opinion, Mr. Douty, if you were going to ship acid or if you were going to store it, that is, a corrosive acid, what life would you expect to obtain from an oil drum, in order to consider it a safe procedure, to store or to ship that acid in such a drum. A. The answer to that is the same as the answer of the famous mechanical engineer to the question "Is a boiler safe?" It is safe if it doesn't blow up.

Q. How would you find out whether or not these drums were safe or not, try them out and if they blew up they wouldn't be safe, and if they didn't blow up they would be safe; is that the idea? A. Pretty near. But one could do better than that. You can screw a pressure gauge into the bunghole and find out when the pressure got excessive, over a course of time.

Q. What would you consider to be excessive pressure so as to render it unsafe to store or ship a corrosive acid in a steel drum? A. Any pressure which exceeded or approached the calculated safe strength of the drum. I have mentioned pressure because, you don't mind my explaining this, I mentioned pressure because the product of reaction of the acid with the metal is hydrogen, Your Honor, and hydrogen is a gas, and if it accumulates in the small space above the liquid until there is an excessive pressure, the drum would explode.

The Court: I supposed when you started you were inquiring about how long before it would eat through. Safe in that direction. A. It isn't safe; it doesn't have to eat all the way through.

The Court: But that is what you were asking about?

Mr. Owen: I am trying to get an idea of what would be a safe drum in which to store or ship the acid.

The Court: Well, what did you have in mind, whether the acid is going to eat a hole in it, or whether it is tight enough or strong enough, or what?

Mr. Owen: Well, I should say that there are two possibilities, and one would be that the pressure would blow the drum up, and another one would be that the acid corroded through.

The Court: This is the first I have heard about that blowing up business.

Mr. Owen: What would be the effect, Mr. Douty, if you placed a corrosive acid in a drum and closed the opening to the drum tightly? A. Well, if you filled the drum pretty near full when you started, which is the custom, in other words, a drum might hold, level full, fifty-three and a half or fifty-four gallons, and you put in fifty two gallons of liquid, that leaves a comparatively small air or gas space. Therefore, it doesn't require the introduction of a great deal of gas from whatever source to build up the pressure, and in the most cases long before the drum was eaten anywhere near through you could notice the ends of the drum, which is made like a barrel with flat heads, begin to bulge.

Q. And that would be a danger signal, do you think? A. It certainly would.

Q. What would you expect to happen? A. I would expect if you let it go long enough, that something would let go somewhere.

Q. It would blow acid all over the place? A. It certainly would.

Q. If a corrosive acid were placed in a drum for shipping in interstate commerce, such products, for instance, as you may have, how long would you expect would be a safe time to allow for that drum to hold? What would you think would be a margin of safety so that the drum would not be likely to blow up in transit or after it reached its destination and was stored temporarily until the purchaser wished to use it? A. That is hard to say. We have shipped many drums of material to Europe, acid material in steel drums; we have shipped it to India, to Indo-China, to Australia. We have shipped them pretty well all over the world, and some of those voyages are fairly long.

Q. Several months? A. I think several months would be a representative figure as to a maximum.

The Court: Any trouble with any of them? A. Yes.

The Court: Did some of them blow up? A. No, sir, not ordinarily. I do not think we ever had one blow up, that I recall.

Mr. Owen: Were those acids? A. Yes, sir.

Q. Or acid solutions? A. Well, we always used solutions in that sense, if they were not labeled acids, or some other name—

Q. Oh, Murodines, Rodines, and things like that, is that what you refer to? A. Those and the Deoxidine and the Deoxylyte.

The Court: When the hydrochloric acid eats iron, then the gas that accumulates is hydrogen? A. Correct.

The Court: Just the same as when it eats the rock formation, it is carbon dioxide? A. Yes, Your Honor.

Mr. Owen: Which one or ones of your products have you shipped on these long voyages? A. I have no records before me, but I fancy about every product that you ever heard of has gone on a long voyage.

Q. In those products which have been shipped in steel you used arsenic, did you not? A. Always.

Q. You never shipped any product on such a long voyage that did not contain arsenic? A. Correct. That is, in steel.

Q. Now, what is the practice of shipping sulphuric acid in steel? I don't mean by you—I mean general practice, if you know. A. Concentrated sulphuric acid is commonly shipped in steel, steel tank cars.

Q. And what do you mean by concentrated sulphuric acid? A. Sulphuric acid of 60° Baume or over. I think 60° Baume corresponds to—well, I will look it up—that is the weakest acid that is commonly shipped in steel. (Witness refers to records.) That is 77.67% sulphuric acid.

Q. That is, Mr. Douty, 60° Baume is 77.67%. A. Yes, that is right, per cent sulphuric. H_2SO_4 is 77.67%. As a matter of fact, Mr. Owen, most sulfuric acid is shipped at 66° Baume, where it is 93%. It is not commonly considered safe to ship 60°.

Q. It is considered safe to ship 66° Baume sulfuric? A. Yes, sir.

Q. And what is the per cent? A. 93%.

Q. And that has been true for many, many years,

hasn't it? Long prior to the Gravell patent? A. Oh, yes.

Mr. Owen: At this point, Your Honor, I wish to read the Interstate Commerce Commission regulations for transportation of explosives and other dangerous articles by freight, including specifications for shipping containers. This is Freight Tariff No. 4 issued January 6, 1941, effective January 7, 1941. On page 94, Section 272(a) it reads as follows:

"Sulfuric acid (oleum, oil of vitriol, etc.) must be packed in specification containers as follows:

"(b) Spec. 15A, 15B, 15C, 16A, or 19A.—Wooden boxes with glass or earthenware inside containers not over 1 gallon each, except that inside containers up to 3 gallons each are authorized when only one is packed in each outside container.

"(c) Spec. 31.—Jugs in tubs. Jugs not over 2 gallons each and only one jug in each tub.

"(d) Spec. 11A or 11B.—Wooden barrels or kegs with glass or earthenware inside containers not over 2 gallons each.

"(e) Spec. 1A or 1C.—Carboys in boxes or kegs; authorized only for acid of not over 100.5 per cent H_2SO_4.

"(f) Spec. 103A.—Tank cars.

"(g) Spec. 5A.—Metal barrels or drums only for acid of 1.81 specific gravity (65° Baume) or greater strength or when the strength of the acid is 60-65° Baume and the acid has been treated with an inhibitor that renders its corrosive effects on steel no greater than 66° Baume commercial sulfuric acid."

The rest of the section relates to lead lined metal barrels, rubber lined metal barrels or drums, in which we are not particularly interested, and so I will not read it.

Mr. Owen: Now, in view of those specifications, would you say that 66° Baume sulfuric acid would be a safe standard of comparison for determining whether or not it would be safe to store or ship an acid in a steel drum within the meaning of the Gravell patent? A. The person or persons who wrote that specification appeared to think so. I don't

necessarily agree with them. I feel that 66° Baume sulfuric acid is very slightly corrosive, indeed, to most steel. A somewhat higher degree of corrosion might be permissible.

Mr. Owen: Now I wish to read the specifications for the shipment of hydrochloric acid. Reading from page 91, Section 263(a) "(1) Hydrochloric (muriatic) acid and hydrochloric acid mixtures must be packed in specification containers as follows:

"(a) (2) Spec. 15A, 15B, 15C, 16A, or 19A.—Wooden boxes with glass or earthenware inside containers not over 1 gallon each, except that inside containers up to 3 gallons each are authorized when only one is packed in each outside container.

"Wooden boxes with glass or earthenware inside containers not over 1 gallon each, except that inside containers up to 3 gallons each are authorized when only one is packed in each outside container.

"(a) (3) Spec. 5D.—Rubber-lined metal barrels or drums. Any such container that shows evidence of damage must be tested, before shipment, for defect in lining in the manner prescribed in spec. 5D."

And the next one:

(Reading): "(a) (4) Spec. 43A.—Rubber drums.

"(a) (5) Spec. 11A or 11B.—Wooden barrels or kegs with glass or earthenware inside containers not over 2 gallons each.

"(a) (6) Spec. 1A or 1C.—Carboys in boxes or kegs.

"(a) (7) Spec. 10A.—Rubber-lined wooden barrels or kegs.

"(a) (8) Spec. 103B, 108, or 108A.—Tank cars."

Mr. Owen (reading):

"(b) (1) Hydrochloric acid of not over 20 per cent strength (13.25° Baume) and other corrosive liquids containing not over 20 per cent hydrochloric acid in addition to containers prescribed in sec. 263(a) may be shipped in specification container as follows:

"(b) (2) Spec. 10A.—Asphaltum-lined wooden barrels or kegs.

"(c) When hydrochloric acid contains oils or solvents it must not be shipped in containers or tank cars lined with rubber."

That is the end of the specification for hydrochloric acid.

Mr. Owen: I would like to find what those tank car specifications are, Your Honor. While we are waiting for that section of the regulations, I will ask a few questions.

Q. On these foreign shipments that you refer to, am I correct in understanding that the products were those that you have previously described as Rodine, Murodine, Deoxidine, Deoxylyte? A. I think that includes all the important ones. Not Murodine, we do not ship that in steel.

Q. Oh, you do not ship that on long journeys? A. We do not ship it at all in steel.

Q. But you do ship Rodine, the Deoxylyte, and the Deoxidine, is that right? A. Yes. Sometimes, Mr. Owen, there are special regulations by the shipping companies as to what kind of packages they will take the stuff in, so you have to pack it that way, but I know we have shipped all those products in steel on boats.

Mr. Owen: Well, Your Honor, Mr. Conner gives me this information which he has taken from these freight regulations, and which we will confirm later. We haven't been able to locate the place in them. He says that Tank Specification No. 103B is rubber lined; Tank Specification No. 108 is rubber lined; Tank Specification 108A is asphaltum lined. That is in connection with the shipment of hydrochloric acid.

The Court: By whom?

Mr. Owen: Anybody in Interstate Commerce.

The Court: That is just what you read to me.

Mr. Owen: I read to you in one paragraph, which simply specified these three tanks without telling what they were; specified them by number. I undertook to locate in the regulations the specifications for those particular numbered tanks. I haven't been able to find that but Mr. Conner tells me he has looked it up and that Tank 103B is

rubber lined, Tank No. 108 is a rubber lined tank, and Tank No. 108A is asphaltum lined. Those are acceptable for the shipment of hydrochloric acid.

Mr. Owen: I want to ask you again, Mr. Douty—I think I have referred to it once, but I am not entirely clear—if it is not a fact that the products your company manufactures and sells and which you have named, are compounds containing acids and not acids themselves? In other words, instead of shipping acids you are shipping compounds containing acids; that is right, isn't it? A. Well, I don't really recognize any distinction, but for the sake of clarity I will say that we have not, to my knowledge, shipped any material marked such and such kind of acid. We have shipped materials marked Deoxidine or Rodine or what they may be.

The Court: Well, is it inhibited acid or is it just the inhibitor? A. Well, Your Honor, it is both ways.

The Court: I see. All right. You sell both the inhibitor for people to put in acid, and you sell it all ready for use. A. That is right. But in that case we haven't sold it as inhibited acid, Your Honor. We haven't named it inhibited acid or whichever. It had some trade name.

Mr. Owen: You don't sell any acid as such, do you; for instance, you don't advertise that you manufacture and sell phosphoric acid, hydrochloric acid, or any other acid? A. I don't think we advertise it, but we do sell phosphoric acid as such; we have a plant for producing it and we sold that, and what we buy from other sources.

Q. How do you ship that phosphoric acid. A. In all packages, not steel.

Q. In glass, rubber-lined tanks, and so forth? A. Yes, sir.

The Court: Do you sell hydrochloric acid as such too? A. No, Your Honor. We have shipped inhibited hydrochloric acid under the name of Rodine, for cleaning out radiators.

Mr. Owen: Regarding the tank car specifications for the shipment of hydrochloric acid, which were referred to

in the quotation I read from the regulations as specifications 103, 108 and 108A for tank cars, I have here a copy of the Interstate Commerce Commission regulations, dated September, 1930, which contains the specifications for those three types of tank cars, and they are rather lengthy. The one for tank car 103 is found beginning page 399; tank car 108 begins on page 432, and 108A begins on page 435, and I find that the first two are rubber-lined cars and the other is an asphalt-lined car.

Vol. III

TRANSCRIPT OF RECORD

(Pages 989 to 1500)

Supreme Court of the United States

OCTOBER TERM, 1944

No. 50

THE DOW CHEMICAL COMPANY, PETITIONER,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY

No. 31

HALLIBURTON OIL WELL CEMENTING COMPANY, PETITIONER,

vs.

THE DOW CHEMICAL COMPANY

ON WRITS OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SIXTH CIRCUIT

PETITIONS FOR CERTIORARI FILED { APRIL 6, 1944.
APRIL 17, 1944.

CERTIORARI GRANTED MAY 15, 1944.

Supreme Court of the United States

OCTOBER TERM, 1943

No.....

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Petitioner,

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HALLIBURTON OIL WELL CEMENTING COMPANY,
a Corporation,
Respondent.

Transcript of Record

On Petition for Writ of Certiorari to the United States Circuit Court of Appeals for the Sixth Circuit

Volume III—Pages 989 to 1500

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IN THE

UNITED STATES CIRCUIT COURT OF APPEALS

FOR THE SIXTH CIRCUIT

No.....

THE DOW CHEMICAL COMPANY, A CORPORATION,
Plaintiff-Appellant,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY,
A CORPORATION,
Defendant-Appellee.

Appeal from the United States District Court for the Eastern District of Michigan, Northern Division

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PRIMA FACIE WITNESSES

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	Direct	Cross	Redirect	Recross
Alquist, Francis N.	1359			
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2	Grebe patent 1,916,122	15	1504
3	Grebe-Stoesser patent 1,998,756	15	1509
4	Chamberlain patent 2,024,718	15	1512
7	Bureau of Mines Bulletin 148	29	Vol. I, 29
9	Chart of patent applications involving use of acid in wells, filed from 1866 to 1939	63	1515
9½	Revision of Exhibit 9	80	1516
10	Chart entitled "Streams of Knowledge"	65	1517
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	Ball 670,577	70	1533
	Mitchell 825,745	50	1537
	Dunn 1,067,868	50	1541
	Muehl 1,410,827	71	1546
	Lake et al. 1,498,045	73	1549
	Tilton 1,608,869	74	1552
	Atkinson 1,651,311	53	1558
	Ranney et al. 1,806,499	75	1565
	Bowman 1,809,546	77	1570
	Young 1,858,847	55	1575
	British Patent 158,768	94	1578
	Millon article (1845)	83	1581
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12	Summary of Dow Shipments of acid with inhibitors February 11 to November 10, 1932	113	1591–96
13	Letters, dated June 13, 1932, to January 19, 1933, from oil industry inquiring about new Dow process of acid treatments for oil wells	148	1597–1625
14	Item in Midland paper regarding new Dow well treating process, dated June 9, 1932	148	1626

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19	First invoice of defendant for acidizing well, dated March 11, 1935	248	1627
20	Second invoice of defendant for acidizing well, dated May 25, 1935	248	1628
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23	Purchase order from Erle P. Halliburton, Inc., dated 5/21/34, for acid treatment of well by Dowell, Inc.	250	1629
26	Ditto, dated October 24, 1934	250	1630
27	Bulk material sales receipt for 1,000 gal. Dowell X acid delivered by Dowell Inc., to Erle P. Halliburton, Inc., dated November 9, 1934	250	1631
31	Agreement dated March 15, 1934, for acidizing two wells by Dowell, Inc., for Steen Drilling, Inc.	251	1632
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38	Order from Steen Drilling, Inc., dated 3/15/34, for acid treatment by Dowell, Inc.	254	1639
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59	Ditto, dated 9/16/34	254	1644
60	Purchase order from Steen Drilling, Inc., dated 9/16/34, for 1,500 gal. acid job by Dowell, Inc.	254	1645
62	Receipt, dated 10/24/34, for well treatment performed by Dowell, Inc., for Erle P. Halliburton, Inc.	254	1646
64	Ditto, dated 11/14/34	254	1647
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67	Stipulation re testimony of R. E. Heithecker.	213	Vol. I, 213
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93	Article in Oil City Derrick of October 10, 1895, entitled "A Great Discovery," reporting acid treatment of well by Frasch and Van Dyke.....	1194A	1651–54
94	Table of Dowell, Inc., statistics showing growth from November 10, 1932, to 1940, inclusive. (See also Plaintiff's Exhibit 232.).....	161	1655
99	Well completion data Greendale (Michigan) oil field.....	168	Vol. I, 168
142	Carnegie Library Card cataloging available issues of Oil City Derrick...	1194A	1656
143	Item in Oil City Derrick for October 28, 1895, reporting acid treatment of wells by Frasch and Van Dyke.....	1194A	1656
144	Ditto, for November 9, 1895.....	1194A	1657
145	Ditto, for January 15, 1896.....	1194A	1658
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150	Stipulation re Williams Bros. record..	13	Vol. I, 13
153	Gypsy Oil Company correspondence and reports re removal of "Gyp" scale and prevention of formation of "Gyp" in oil wells of the Glenpool, Okla., field	1087	1664–1704
154	Bartell Table showing results of corrosion tests with defendant's truck (treating) acids on strap iron test pieces	329	1705
155	Ditto, showing results on test pieces of oil well pipe from National Supply Co.	333	1706
156	Ditto, showing results on test pieces of oil well pipe from Oil Well Supply Co.	333	1707
157	Ditto, showing results on test pieces of oil well pipe from Atha Supply Co..	334	1708
158	Bartell Table showing results of corrosion tests with defendant's storage acids on strap iron test pieces.....	345	1709
159	Ditto, showing results on test pieces of oil well pipe from National Supply Co.	345	1710

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163	Bartell Table showing content of copper, lead and iron in acid used by defendant in treating Zahn well, and same as to acid from defendant's storage tanks	380	1713
164	Bartell Table showing content of copper, lead and iron in acid used by defendant in treating Stella Wilcox well, and same as to acid from defendant's storage tanks	383	1714
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166	Bartell Table showing results of corrosion tests using c. p. (chemically pure) hydrochloric acid solution containing different amounts of copper, lead and iron	394	1716
167	Bartell Table showing effect of agitation and increased quantity of acid on corrosiveness of acid solutions containing different amounts of copper, lead and iron	407	1719
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170	Bartell's chart showing effect of adding copper, lead and iron to 15.1% c. p. hydrochloric acid	428	1721

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183	Ditto re Run 2E. Similar to Run 2B, but with different amounts of copper, lead and iron	517	1741
184	Prutton's summary and conclusions with respect to runs in Exhibits 176-183	534	1742–45
185	Prutton Tables showing results of Runs 1M, 1N, 2M and 2N, using commercial acid from special tank embodying features of defendant's truck tanks	537	1746–49
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187	Prutton graph showing results of runs of Exhibits 176-183	602	1752
188	Prutton graph comparing results of Runs 1M, 1N, 2M and 2N (Exhibit 185) with average of Runs 1A, 1AA, 2A and 2C (Exhibits 176-179)	604	1753
189	Prutton graph showing results of tests of 15% c. p. hydrochloric acid with different added amounts of copper, lead and iron	605	1754
192	History of oil development in limestone fields prior to 1932 and history of acidizing in those fields beginning in 1932, prepared by the witness Fitzgerald	178	1755–70
195	Item from Montana Oil & Mining Journal for January 26, 1935, reporting increase of production in Pondera (Montana) field, due to acidizing	186	1770
196	Bulletin of Montana Oil Conservation Board	189	Vol. I, 187
199	Letter, Dow Co. to Oil Makers, 9-23-32	1171	Vol. III, 1172
200	Letter, Grasselli to Oil Makers, 10-14-32	1174	Vol. III, 1174
201	Letter, Grasselli to Oil Makers, 11-1-32	1175	Vol. III, 1175
202	Letter, Grasselli to Oil Makers, 1-26-33	1176	Vol. III, 1178
203	Letter, Grasselli to Oil Makers, 9-15-32	1179	Vol. III, 1179
204	Letter, Oil Makers to Grasselli, 10-8-32	1179	Vol. III, 1180
205	Oil Makers checks to Penn. Salt Co.	1196	Vol. III, 1196
216	Letter, Lee to Oil Makers, 2-7-33	1243	Vol III, 1242
218A-218D	Pages from notebook kept by the witness Sprenger	1257	1772–74
219, 220	Photograph of standing valve and working valve	1268	1775
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232	Table supplementing Exhibit 94	845	1787
233	Summary of well treatments made by licensees of Dow other than Dowell	845	1788

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234	Sketch and data prepared by Dr. Prutton showing rates of attack on oil well tubing of 15% c. p. hydrochloric acid and of 15% synthetic defendant's treating acid	840	1789
242	Dowell advertisement in Petroleum World, September, 1938	846	1790
243	Ditto for January, 1939	847	1791
245	Dowell, Inc., Service Price Schedule 110.	852	1792
246	Record of shipments of hydrochloric acid and arsenic inhibitor by Dow Company for period January to June, 1932, inclusive	121	1793
305	Affidavit of Robert Quinlan on the first treatment of a Pure Oil Company well with inhibited hydrochloric acid.	1028	1794
328	Table showing results of acid treatments of gas wells by Dowell, Inc., prepared by the witness Lyons	191	1796
329	Ditto, showing additional treatments and data	193	1797
330	Table showing time acid was in tubing in each of 122 acid treatments made by Dowell in Kansas from March to September, 1936, in 97 consecutive Arbuckle dolomite wells	197	1798
331	Data showing average time acid was in tubing in making the 122 treatments itemized in Exhibit 330	197	1799
337	Chart showing combinations possible under claims of Gravell Patent 1,678,775.	1320	1800
343	Alquist Table showing rate of corrosion of mild steel in various concentrations of hydrochloric acid	1365	1801
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344	Alquist Table showing acceleration of the rate of corrosion of hydrochloric acid containing an acid regulator caused by the addition of tin, cobalt or nickel	1370	1804
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347	Table supplementing Plaintiff's Exhibit 252	1404	1806
348	Table showing treatments by Dow licensees other than Dowell	1404	1807

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349	Table showing summary of royalty charged by Dow Company to licensees.	1404	1808
350	Table showing quantities of inhibited acid and other materials used by Dowell, Inc.	1405	1809
350A	Graph illustrating data in Exhibit 350.	1407	1810
351	Acidizing orders, tickets and other data from defendant's files relating to wells at which plaintiff secured samples of defendant's truck (treating) acids	1406	1811–24
354	Dowell advertising data for years 1932 to 1934	1407	1825
355	Photograph of one-half gallon container used in Alquist's tests, and table and graphs showing results of tests.	1376	1827–29
356	Photographs of 10-gallon drum and of equipment used by Alquist in making tests, and tables and graphs showing results of such tests	1380	1830–40
357	Table, graphs and drawing of equipment used by Alquist in making tests showing loss of strength of 15% hydrochloric acid when in contact with iron for different periods up to 24 hours.	1398	1841–46
358	Bartell Table showing summary of corrosion tests of various commercial hydrochloric acids of 15.1% strength.	499	1847
360	Table showing Dowell advertising 1932 to 1940, inclusive	1408	1848
362	Poffenberger's report on acid treatment of Dow Company's brine well No. 77	1418	1849–53
363	Poffenberger's report on acid treatment of Dow Company's brine well No. 80	1418	1854
364	Poffenberger's report on tests of inhibiting value of arsenic compounds in hydrochloric acid	1423	1855
366	Carr and Humphrey patent application for method for increasing fluid production from oil wells	1427	1857–64

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367	Carr and Humphrey patent application on chemical reagent for use in oil wells	1428	1864–68
368	Carr and Humphrey patent application for method for introducing acid reagents into oil wells by gas pressures	1428	1868–72
369	Agreement between The Dow Chemical Company and The Pure Oil Company dated January 31, 1933	1428	1873–77
370	Agreement between The Dow Chemical Company and The Pure Oil Company dated June 30, 1934	1428	1877–82

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8	Excerpts from article by R. Van A. Mills, dated December, 1923, entitled "The Paraffin Problem in Oil Wells".	35	1883
72	Letter from M. G. Harper to J. W. Van Dyke, dated December 5, 1895	1033	1884
73	Telegram, Harmon to Van Dyke, dated January 24, 1896	1033	1885
74	Memo from C. F. Lufkin to Van Dyke, undated.	1033	1886
83	Telegram, J. C. Donnell to Van Dyke, dated November 25, 1895		1887
86	Telegram, Harper to Van Dyke, dated December 6, 1895		1887
88	Letter, The Grasselli Chemical Company to Van Dyke, dated July 26, 1895		1888
90	Letter, Herman (Frasch) to Van Dyke, dated September 22, 1895		1889
101	Letter, Harper to Van Dyke, dated December 16, 1895	1033	1890
102	Letter, Harper to Van Dyke, dated December 16, 1895	1047	1891
103	Letter, Ohio Rubber Company to Solar Refining Co., dated September 21, 1895.	1047	1892
104	Letter, Ohio Rubber Company to Solar Refining Co., dated September 25, 1895.		1893
105	Memo re Crossley Well No. 3 of Ohio Oil Company	1047	1894

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108	Letter, Harper to Van Dyke, dated February 5, 1896	1047	1895
109	Correspondence between Lufkin, Van Dyke and Donnell re acid treatments (July, 1895, and February, 1896)	1047	1896
110	Letter, Lufkin to Van Dyke, dated July 29, 1895		1900
111	Letter, Harper to Van Dyke, dated December 2, 1895	1047	1902
112	Letter, Grasselli Chemical Company to Van Dyke, dated November 21, 1895		1903
113	Letter, Van Dyke to Grasselli Chemical Co., dated November 20, 1895		1904
114	Memo dated November 21, 1895		1905
115	Letter, Frasch to Van Dyke, undated		1905
132	Letter, Grasselli Chemical Co. to Van Dyke, dated July 19, 1895		1906
138	Letter, Lufkin to Van Dyke, dated August 2, 1895		1907
151	Report on scale formation in wells by Blaine B. Wescott	1081	1908–21
152	Report by F. W. Karl, dated February 1, 1929, re treatment of William Berryhill Well No. 8	1087	1922
153	Same as Plaintiff's Exhibit 153	1087	1664–1704
191V	Gardner Affidavit	750	Vol. II, 752
221	Letter, Robinson to Prutton, 9-12-39	769	Vol. II, 769
222	Letter, Rebbeck to Prutton, 1-24-41	771	Vol. II, 772
223	Letter, Prutton to Rebbeck, 2-19-41	774	Vol. II, 775
224	Letter, Rebbeck to Prutton, 7-10-41	791	Vol. II, 791
225	Letter, Rebbeck to Prutton, 7-9-41	792	Vol. II, 791
226	Letter, Rebbeck to Prutton, 7-9-41	792	Vol. II, 793
227	Letter, Rebbeck to Prutton, 7-11-41	792	Vol. II, 793
280	Hathorn's chart re tests on hard steel tank No. 1	854	1924
281	Hathorn's chart re tests on hard steel tank No. 2	854	1925
282	Hathorn's chart re tests on hard steel tank No. 3	854	1926
283	Hathorn's chart re tests on soft steel tank No. 4	854	1927
284	Hathorn's chart re tests on soft steel tank No. 5	854	1928
285	Hathorn's chart re tests on hard steel tank No. 1	854	1929
286	Hathorn's chart re tests on soft steel tank No. 4	854	1930

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DEFENDANT'S EXHIBITS

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287	Index for Hathorn's corrosion experiments	855	1931
288	Photograph of Hathorn's hard steel tank No. 1	855	1932
289	Photograph of Hathorn's soft steel tank No. 4	855	1933
294	Prior art patents	912	1935–88
	Frasch 556,669	68	1935
	Laverty 856,644	913	1939
	Beneker 914,916	915	1941
	Gravell 1,398,507		1943
	Holmes 1,470,225	916	1945
	Gravell 1,678,775	95, 897	1947
	Gravell and Douty 1,678,776		1950
	Fischer et al. 1,736,282	917	1954
	Rhodes 1,746,677	918	1957
	Rhodes 1,746,678	920	1961
	Vignos 1,750,651	920	1964
	Harrison 1,766,902	921	1968
	Corson et al. 1,773,953	921	1971
	Lawrence 1,780,594	922	1974
	Lawrence 1,780,595		1976
	Calcott 1,785,513	923	1978
	Burke 1,789,805	923	1980
	Corson 1,809,621	923	1985
	Carr 1,891,667	76	1988
300	Memorandum given by Grebe to defendant's witness Thomas	1012	1993
301	Letter, C. Plummer to The Dow Chemical Company, dated December 1, 1932	1016	1994–97
302	Memorandum of conversation with Ross T. Sanford, dated December 8, 1932.	1016	1998–99
303	Memorandum of conversation with John J. Grebe, dated December 8, 1932.	1023	2000–02
304	Preliminary draft of patent application of John J. Grebe, dated June 7, 1932.	1025	2002–09
312	File history of Grebe and Sanford patent 1,877,504		2010–46
314	Conception data sheet signed by John J. Grebe July 2, 1932		2047

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FRANK PALIN SPRUANCE,

testified as follows by deposition:

DIRECT EXAMINATION

My residence is 8204 Cedar Road, Elkins Park, and my occupation is vice-president of the American Chemical Paint Company, at Ambler, Pennsylvania. I have been connected with the American Chemical Paint Company since 1920 or '21, in connection principally with sales. I was graduated a mechanical engineer from the University of Pennsylvania but have had very little to do with the technical work of the company. Mr. Douty, and formerly Mr. Gravell, now deceased, have had charge of that work since my connection with the company. Mr. Gravell was president of the company. The company maintains a technical laboratory. It has maintained it since about 1923, when Mr. Douty came with it. Previous to that time Mr. Gravell did all of the development work and all of the chemical work for the company. Mr. Douty organized this laboratory work, under Mr. Gravell's supervision, and has worked very closely with Mr. Gravell in the technical developments. Mr. Gravell has been dead since December of 1939. During the first few years the company had the technical laboratory there were only two on the technical staff, Mr. Gravell and Mr. Douty, and they worked side by side and hand in hand, collaborated very closely. That would apply up to the year that Mr. Gravell died. Mr. Douty's official title was chief chemist, and has been at all times. My duties at times have had to do with the sales end.

The principal business of the American Chemical Paint Company when I first became connected with it was the manufacture and sale of acid cleaners, for preparing metals for painting, and in addition, soldering fluxes used on metal, and in addition to that we had a product known as

Lithoform, which was used to coat galvanized iron so that the paint would adhere to it. The Deoxidine was the only one of those products that contained acid. It contained phosphoric acid. It was originally shipped in wooden barrels with a rubber lining. We used the rubber lining because it was the only container we found that we could suitably carry the Deoxidine in, and even so, we had a great deal of trouble with the Deoxidine leaking out through pinholes in the rubber and getting onto the hoops and corroding the hoops, and the barrel went to pieces. Without the rubber lining that would have happened very, very quickly. That method—I don't remember exactly the date, but I think that that continued until about 1926. We continued to manufacture and sell Deoxidine after that date and shipped it in steel drums, and still do.

As to other acid products our company now manufactures inhibitors, the trade name of which is Rodine. We have another inhibitor of the Rodine type, which we designate as Murodine. Sulphuric and muriatic acid are used in those products, but both acids are not used in the same product. We would have muriatic acid in the case of one particular Rodine, and we would have sulphuric acid in the case of other Rodines, but I know of none in which both acids are used. We have sold Rodine—I have forgotten the date, Mr. Douty can give you the dates more accurately that I can, but I would say from about 1923 on. Murodine we first made and sold about 1926 or '27. I think muriatic acid was used in Murodine. That is still manufactured and sold. In some Rodines we use sulphuric acid as an ingredient and in other Rodines we use muriatic acid or hydrochloric acid as an ingredient, and in Murodine we use only the hydrochloric. But let me make this explanation, that I wouldn't want to be held too definitely to the formulation of these materials. Now, there may be some small amount of one or the other acid in one of these materials which may come in in the process of manufacture, but the Murodine, as I remember it, is predominantly muriatic acid.

We manufacture phosphoric acid ourselves, at Newcastle, Delaware, and ship it in rubber lined barrels. We ship our Rodine in steel drums and we ship our Murodine I think, in wood barrels—for a reason. We have always shipped our Rodine in steel drums.

We first began to manufacture and sell Rodine about '23 or '24—now, Mr. Douty has the dates on that more accurately. That is my recollection, '23 or '24. Rodine was used to prevent acid dissolving metal. It was used in the steel industry in a process which is known as pickling, where steel is introduced into diluted acids for the purpose of removing scale, scale being the black oxides of iron. It is also used to remove rust, in some cases. There are some plants where muriatic acid is used. Sulphuric acid is preferable, principally on account of the cost, in the pickling process in the steel mills. Rodine is placed in either one of those acids, according to whichever one is used. Sulphuric acid is used in the pickling industry in strengths which will vary from two per cent to ten per cent by volume and the rest of the volume is water except for the small quantity of Rodine that is also added. The Rodine concentration will vary from one-eighth per cent to one per cent, and that percentage is based on the volume of the undiluted acid, and those percentages which I have just stipulated are such as are used in the pickling in steel mills for the removal of scale, and in miscellaneous industries for the removal of scale or rust. The undiluted sulphuric acid which I have referred to above is either 60 or 66 degree Baume, and the sulphuric acid solution used in pickling in the steel mills is made up of from two to ten per cent of sulphuric acid of from sixty degrees to sixty-six degrees Baume. To that solution there is added from one-eighth of a per cent to one per cent of Rodine.

Hydrochloric acid is used much stronger than sulphuric acid in the pickling industry. The strength of the solutions will vary, and commercially they might be used from twenty per cent to one hundred per cent by volume of the commercial muriatic acid which is either 18 degrees Baume or

20 degrees Baume. Sometimes that 18 degree or 20 degree Baume hydrochloric acid is used undiluted. It is used in diluted solutions perhaps in the same plant. The strength of the acid is the factor which controls the speed of removing scale or removing rust, or removing lime deposits, or removing whatever is to be removed. The stronger the acid, the more rapid the action, in most cases. The concentrations of Rodine or Murodine in muriatic acid pickling solutions will vary widely, but they will range from one-eighth to three per cent by volume of the undiluted commercial muriatic acid.

Our company has carried on a pickling business of its own and we conduct such business now. My testimony regarding the acids used in pickling, and the strengths of acids used, and the proportions of Rodine or Murodine used, is based on operations which we have controlled or advised in the steel mills, in tremendously big proportions, in large quantities, in many mills. My testimony applies to the pickling operations as commonly carried on by the big mills, and we use Rodine and the acid solutions in the same general way in our own pickling, wherever we do it here, and we have generally used it whenever we did, and that, as I said before, has gone back to time immemorial in the history of this company, because we have always had occasion to do some pickling in experimenting with other processes of treating metals.

There are many objects in pickling iron or steel. First, because of the very large tonnage and very general application, I would place the object of pickling as the removal of mill scale, as it is called. Mill scale is the oxide coating which forms on steel when it is heated. This scale must be removed before the steel can be subsequently fabricated. Another purpose for pickling is to remove rust. The effect is much the same, and the use of the solution is much the same as that in pickling for the purpose of removing scale. Another use is for the removal of calcareous deposits from equipment, such as bottle and can washing machines, automobile radiators, wells. The only thing that I would class

as actually the pickling art is the removal of mill scale and the removal of rust. The sheet metal as it comes from the steel mills does not usually have a calcareous deposit on it, and pickling as I have defined it is not usually intended to remove calcareous deposits, but there are times when steel comes from the mill with a coating of lime on it, and with that lime is rust, and in that case the steel is pickled, and the lime and the rust are both removed. If there is any calcareous material on the steel the pickling operation would remove it. I don't know how lime would get on the steel before it comes to the pickling vat, but I know how it would get on the steel after it has gone through the pickling vat, and that is where it is put on, they use the lime to neutralize the spent acid, and a coating of lime and calcium carbonate and probably calcium sulphate is left on the steel. They re-pickle it to remove that material in the fabricating plants. Steel is pickled many times. All steel is pickled many times. Lime is not used in the pickling solution; it is used in a separate wash tank, as a neutralizer to wash the acid off the steel after it is pickled. What they use after the pickling operation which results in putting a lime coating on the pickled material is powdered lime. Just dry powder.

Q. You say you don't know in what form the lime is used for this purpose, except that it is in powder form? A. That is right.

Q. And that is all you know about it? A. That is all I know about it.

My principal reason for knowing that these pickled sheets, after they are treated with the powdered lime, contain a calcareous deposit, is the method of deduction. You have heard that you can't make purses out of sows' ears, and you can't get anything except lime coatings out of a solution that contains lime. In pickling sheets of iron or steel it is desirable to leave the surfaces clean and free from any other materials.

In the pickling operation the Rodine is used to prevent the acid unnecessarily dissolving the metal. In other words,

it is used to protect the metal against acid attack. This statement is made having in mind the addition of the Rodine to the pickling solution in the mills. As to Murodine, this material has not been offered for the pickling industry. That material was developed solely and entirely for use with muriatic acid, as this was used in the oil industry for cleaning oil wells. The purpose of Rodine is to prevent acid attacking metal.

We sell Murodine for the purpose of preventing the attack of acids on metals. That is not sold in the pickling industry, but its purpose is the same purpose. It is not used in the pickling industry under that name. Murodine is of the same nature as our Rodines, but Murodine was so named because it was used specifically in muriatic acid. The bulk of the pickling that we are serving is sulphuric acid and Murodine as compounded is not suitable for use with sulphuric acid. We sell our Rodine and our Murodine to different classes of customers. We do not sell them to the same customer. We sold Murodine to the oil industry, and to no other industry. We sell Rodine to the pickling industry and now to no other, but we did sell Rodine to the oil industry in the early days. By the early days I refer to 1926, '27, '28, somewhere along there.

Mr. Owen: Do you know of your own knowledge the uses for which your Rodine was used in the oil industry in 1926 or 1927 or thereabouts? A. It was used to remove calcareous deposits from oil wells, to increase the flow of oil into the well, and without doing unusual harm to the tubing and casing.

Q. You are testifying of your own knowledge, now? A. I have never seen it so used, but I have heard of its use many, many times.

Mr. Owen: I move to strike out the last two preceding answers as irresponsive and volunteered.

Mr. Owen: Now, I will ask you again, Mr. Spruance, and I warn you that I want your own knowledge and not what someone else told you, do you know of any instance where Rodine was used in the oil industry for any purpose

prior to 1932, and if it was so used, in exactly what way was it used? A. You put me in an embarrassing position, because, as I said before, I never saw it so introduced, but I am just as sure as to how it was used,—

Q. No, no,—

Mr. Richmond: No, just a minute. Go ahead, let the witness answer, and you can move to strike out.

Mr. Owen: I want the witness to confine himself to the question. This witness is not a witness on behalf of the plaintiff in the sense that he is a biased party for the plaintiff. He is really a party-defendant to this case, because it was his company which developed the Gravell patent and which sold it to your company to bring suit against us. Therefore, this witness is not permitted or should not be permitted to volunteer testimony, and he should not be permitted to testify to anything that he does not know of his own knowledge.

Mr. Richmond: Well, he has a right to testify as an official of the American Chemical Paint Company what he knows from its records and from his position as the head of sales of that company.

Mr. Owen: If the witness can—

Mr. Richmond: And I certainly object to your lecturing the witness. You ask him the questions, and if he doesn't give you the answers, why, you have a proper way to get them.

Mr. Owen: Now, I will ask you once more, Mr. Spruance, and in all good nature,— A. I am going to answer you in good nature, too.

(Continued): —If you know of your own knowledge of the actual use of Rodine in an oil well prior to 1932. A. I will again say that I have never seen Rodine put into an oil well for the purpose described, but I will say—

Mr. Owen: Now, I object—

Mr. Richmond: Go ahead. I object to your cutting the witness off.

Mr. Owen: I object to any further statement—

Mr. Richmond: This witness has a right to complete his answer.

Mr. Owen: —unless it is in response to the question.

Mr. Richmond: No, you can move to strike it out. Go ahead and continue your answer.

Mr. Owen: I don't want the witness to state what someone else told him.

Mr. Richmond: Now, complete your answer, Mr. Spruance.

The Witness: This is off the record.

(Discussion off the record.)

Mr. Richmond: Well, I ask that you finish your answer, and then let counsel move to strike it out if he wishes. Go ahead and say what you have to say.

Mr. Owen: Confine yourself to what you know, Mr. Spruance.

The Witness: I am perfectly sure that the—

Mr. Owen: I object to that.

The Witness: —that the Rodine—

Mr. Owen: I object to that, unless you know.

Mr. Richmond: Well, you have objected. Now, let the witness answer, and then move to strike it out as not responsive.

The Witness: —that the Rodine was used for the purpose of protecting the metal equipment in oil wells, because we were in the business of supplying materials for that very purpose, and the people who had the problem of protecting metal in oil wells came to us for relief.

Mr. Owen: I move to strike out that portion of the answer as irresponsive.

Mr. Owen: Now, I will ask you whether of your own knowledge you know of any instance where Murodine was placed in an oil well prior to 1932.

Mr. Richmond: Well, I will stipulate that was not ever used prior to 1932. Go ahead. A. It was not.

Mr. Owen: As your testimony now stands it is that you do not know when Murodine was first placed on the market. That is correct, is it? A. I don't recall the exact date, no.

Q. And that you don't know when Rodine was first

sold for use in the oil industry? A. I don't know the date of that.

CROSS EXAMINATION

I don't know exactly when the American Chemical Paint Company first sold a Rodine to be used as an inhibitor for hydrochloric acid that was to be used in an oil well, but I would say it was somewhere around 1925 or 1926 or 1927. We sold some to the Gulf and we sold some to the Gypsy oil companies.

Referring to a photostatic copy of an order from the Gypsy Oil Company, number 4069, dated September 19, 1928, I feel sure our company received the original of that order because I know we shipped Rodine to the Gypsy Oil Company. There was fifty-two gallons shipped, in a fifty-two-gallon steel drum.

Referring to a photostatic copy of Gypsy Oil Company order number 69422, dated September 23, 1929, with the received stamp of October 16, 1929, thereon for one ten-gallon drum of Rodine Number 2, I recognize that as an order that we received from the Gypsy Oil Company. I can't identify it exactly as to that date, but I know that we shipped Rodine at that time to the Gypsy Company.

Referring to order number 4069 of the Gypsy Oil Company, the Rodine that was called for is Rodine Number 2.

Referring to a photostatic copy of Gypsy Oil Company order number 117624, of August 14, 1930, I don't know whether it is '29 or '30, I recognize that as an order that we received from the Gypsy Oil Company for ten gallons of Number 2 Rodine. That was filled by our company.

Referring to what appears to be an invoice of the American Chemical Paint Company to the Gypsy Oil Company, at Pittsburgh, Pennsylvania, for ten gallons of Number 2 Rodine shipped in a ten-gallon drum, and dated the 12th, looks like '29, I can't make out the date, that is our company's invoice to the Gypsy Oil Company for the shipment to them of Rodine Number 2.

At the time of these four documents that have been called to my attention, my position with the American Chemical Paint Company was vice-president in charge of sales. The company had salesmen under my direction. We had salesmen in Pittsburgh, we had salesmen in Detroit, we had salesmen in Chicago, we had salesmen in the East. Our salesman at Pittsburgh was William S. Dietrich, who now resides in a suburb of Philadelphia. He was the salesman who would have made these sales to the Gypsy and to the Gulf that I have mentioned. He reported to me the purpose for which the Rodine was to be used. He told me that the Rodine had been found very effective as an addition to muriatic acid for the treatment of wells. He was working in collaboration with a Mr. Wescott, who was at that time associated with the Gulf Research. Mr. Wescott had tested the Rodine, and Mr. Dietrich informed me that Mr. Wescott had advised the various branches that Rodine was an effective material to prevent the action of acid on tubings and casings in acidizing wells, and that he had accordingly recommended its use.

Mr. Dietrich at the present time is pensioned. For two years he has been ailing very seriously with coronary thrombosis. He is confined to his bed most of the time and is not able to do any work at all, as a result of which we retired him on a very fair remuneration, and he is living as long as he will live without doing any work at all. His condition as to being able to appear in court I would say is hopeless. He can't even appear downstairs most of the time.

Since those first sales of Rodine Number 2 the American Chemical Paint Company has had Rodine Number 2 or its equivalent on sale for the purpose of removing calcareous deposits in oil wells. Our company has sold its Rodine or Murodine to the plaintiff, Dow, or its totally owned subsidiary, Dowell Incorporated. Such sales were made between 1928 and I would say 1938. I haven't got the exact dates of any sales to Dowell. I have got some figures here, but I can look that up. I think we sold Dowell

Murodine during the years 1936 and 1937. I do not know how much those sales amounted to, but I think I can find out.

Mr. Richmond: Now, can you give me, as briefly as possible, by years, if you would rather, the amount of sales of Rodines, Deoxidines and Murodines since you started making those articles, when they contained arsenic? A. I don't know when they first contained arsenic, but I am sure that is in the records in Douty's testimony; because I wouldn't be too accurate about the date.

1923, we sold approximately $250,595 worth of Deoxidine and $4,034 worth of Rodine. In 1924 we sold $209,061 worth of Deoxidine, and $14,757 worth of Rodine. In 1925 we sold $558,412 worth of Deoxidine, and $105,125 worth of Rodine. 1926, $735,950 worth of Deoxidine, and $133,440 worth of Rodine. In 1927, $901,559 worth of Deoxidine and $152,066 worth of Rodine. In 1928, $1,060,006 worth of Deoxidine, and $240,589 worth of Rodine. In 1929, $1,070,130 worth of Deoxidine, and $332,678 worth of Rodine. In 1930 we sold $591,627 worth of Deoxidine and $242,782 worth of Rodine. In 1931 we sold $230,557 worth of Deoxidine, and $125,712 worth of Rodine. In 1932, $114,477 Deoxidine, and $104,269 Rodine. In 1933, $156,648 Deoxidine, and $202,027 worth of Rodine. In 1934, $200,738 worth of Deoxidine, and $212,036 worth of Rodine. In 1935, $198,956, Deoxidine, and $283,878 of Rodine. In 1936, $223,493, Deoxidine, and $343,055 worth of Rodine. In 1937, $226,368 Deoxidine, and $325,845, Rodine. In 1938, $142,619, Deoxidine, and $188,721, Rodine. In 1939, $161,142, Deoxidine, and $260,656, Rodine. They are figures that are quite approximate—they are taken from a sales curve, they may be off in a few dollars or a few hundred dollars, but the volume is about right.

Mr. Owen: These figures which you have given include all sales of all Rodines of the various numbers which you manufactured? A. That is correct.

Q. Are you able to separate these figures and show what amounts of the different Rodines were sold during

each year? A. Not without a great deal of trouble. I should say this, that in the early days we had one Rodine or two Rodines, they were liquid—they were arsenic Rodines.

Q. And did you sell Deoxidines under different numbers and formulas? A. Yes, but it was about, I would say, about ninety-five per cent one kind; that is, there were a few special Deoxidines sold in very small quantities for certain specific customers, but the bulk of it was the standard grade.

Mr. Owen: I object to the figures with reference to Rodine unless they are separated into the different Rodine numbers. In bulk they don't mean anything, in my opinion.

Mr. Richmond: The Rodines, though, all contained—all the liquid Rodines contained arsenic? A. That is correct.

Mr. Owen: While we are on this question I think I should dispose of it. Do those figures that you have given for Rodines include any solid or powdered Rodines? A. In the later years, but not in the earlier years.

Q. In what years? A. Mr. Douty has given you the formula for 106 Rodine, which was our first powdered Rodine.

Q. And the sales of powdered Rodines are included in these figures you have given? A. In the later years, yes.

Mr. Owen: I object to the answer in so far as it relates to Rodines on the ground that it is indefinite, and does not set forth the Rodines which might be construed as coming under the Gravell patent in suit.

Mr. Richmond: Mr. Spruance, you have now, have you, before you the date of the first sale to Dow Chemical Company? A. I do. Of a Rodine, first sale is 4th month, 19th, 1935. I don't know what number it is now. It is Rodine. The first sale to Dowell Incorporated was 4th month, 19th, 1935. I have records of sales of Murodine to Dowell Incorporated here for the years 1935, 1936 and 1937. The sales to the Dowell Incorporated of Murodine for the year 1935 were $3,000. For 1936, $3600. For 1937, $232.50.

In the years 1935, '6 and '7, the total amount is $6,832.50. I haven't differentiated between Dow and Dowell. These figures cover both. I do not know why Dow Chemical Company and Dowell Incorporated quit purchasing Murodine from our company.

REDIRECT EXAMINATION

The figure of $6,832.50 which I gave for the total sales to Dowell and Dow covers all sales of our products to both of those companies during the years I mentioned. I cannot from the meager records I have before me, separate the Rodine sales from the Murodine sales or the different Rodines. I would say that they would include not over one Rodine and one Murodine. My personal recollection is that it was all Murodine 101. My recollection is that there was no Rodine. The $6,832.50 are sales of Murodine 101, if my recollection is correct.

I have no information regarding the use or uses to which the Gypsy Oil Company put the Rodine which it purchased from us, other than what appears on the orders themselves or what I said our salesman Dietrich told me. I have no personal information regarding the use to which that material was put.

The only sale of our materials to the Dow Chemical Company or Dowell Incorporated during those years other than Murodine would have been Rodine, and that is where my memory is not completely accurate as to whether it was Rodine and when it changed from Rodine to Murodine, but it was either Rodine Number 4, or Rodine Number 40, or it was Murodine Number 101.

RECROSS EXAMINATION

The information received concerning the Rodine sold to the Gypsy Oil Company was received by me in the regular order of business of the American Chemical Paint Company and in my official capacity as sales manager of that company from a salesman under my direction.

REDIRECT EXAMINATION

On the sales which we made to the Gulf Oil Company I have no information as to the uses to which the products were put other than what appears on the orders or what our salesmen told me other than that the salesmen reported to me that they were used for well cleaning, along with muriatic acid.

Mr. Owen: That was for cleaning "gyp" from the pipe? A. No, that was for increasing the flow of oil in the well.

Mr. Owen: Well, I object to the testimony as hearsay, and renew my motion to strike it from the record.

PAUL W. PITZER,

a witness for defendant, testified by deposition, as follows:

DIRECT EXAMINATION

I live in Breckenridge, Texas, and am in the oil and acidizing business. I am vice president of The Chemical Process Company, which company was incorporated in Texas in 1932 and is in the business of acidizing oil wells. I have been engaged in the business of acidizing oil wells continuously since 1932. The Chemical Process Company was organized for the purpose of acidizing wells. I am also

an oil man and have been for a number of years prior to the organization of The Chemical Process Company. Prior to the organization of that company I and my associates acidized some few oil wells, less than ten, I would say. Some of these wells were my own, the remainder belonged to others. These wells were located in Stephens County, Texas.

Mr. Babcock: Would you please describe briefly just what process or method you have employed in acidizing oil wells. First, state briefly just what you did prior to the organizing of the Chemical Process Company, and then go on and describe in general the process employed by The Chemical Process Company, and if there was any difference in what you did before and after it was organized? A. Why, there was not a bit of difference. On our first treatment we treated a well with 730 gallons of acid. This well belonged to Pitzer and West, that is, myself and partner, who were in the oil business together and worked at that business. Our records show this well was treated on October 13, 1932. We used muriatic acid in treating this well. We ordered it in carboys. I am not positive, but I think it came from the Texas Chemical Company at Houston, Texas. There was no inhibitor or other chemical used in treating this well. We used just straight acid. We mixed it with water and made a fifty-fifty solution. The acid was 18 Baume diluted down to a fifty-fifty solution, which would make a 15 Baume acid. The nature of our treatments after the organization of the Chemical Process Company was the same and is the same today. Our treatments consisted in just putting the acid into the oil well and displacing it either with water or oil to push it back into the formation. The acid was forced into the formation using whatever method was necessary, either from vacuum or from pressure.

Since the organization of The Chemical Process Company to date that company has made approximately fifteen thousand acid treatments to oil wells. This work has been done for practically the entire oil business. I mean by that,

that there are only a few oil companies for whom we have not acid-treated oil wells. We have treated oil wells for all the major oil companies, except The Pure Oil Company. I do not think we have ever treated a well for the Pure.

In these thousands of treatments we have made, we have used an inhibitor on a few wells. We did not use any inhibitor in 1932 or in 1933. We used the last inhibitor on a few wells during the period between the time of the decision in The Dow Chemical Company vs. Williams Brothers Well Treating Corporation suit, between the time it was tried and reversed. It was between the time of the trial of that case and the time the Appellate Court in Denver reversed it. We only used an inhibitor on a few wells between that time and the time it was reversed. It was not our common practice. After the reversal of that case we never used any more inhibitor and we have not used any since that time. We have not used any inhibitor since that case was decided on appeal.

Q. (Exhibiting instrument to witness): I hand you some kind of mimeographed document of 5 pages and will ask you what that is, if you know? A. Well, laying aside a chance for a few mistakes being made, that is supposed to be our business records of the wells we have treated, which we keep.

Q. Did you keep a record of only a part of the wells you treated? A. No, that's supposed to be a complete record through those dates on there, from the time we treated the first well for one year. That's a complete mimeographed copy of the wells we treated the first year.

(The document was offered and received as DX-298.)

The Witness: This document is an entire list of treatments made by the Chemical Process in the Breckenridge, Texas, district. The list is subject to error, but I understand it to be a list of wells which The Chemical Process Company treated on the dates listed. The list gives the amount of acid used on each well, which amount is correct to the best of my recollection. No inhibitor was used in any of these wells listed in DX-298, which list covers wells we

treated from October 13, 1932, to October 13, 1933, during the first year of the existence of The Chemical Process Company. All these wells were located in Texas, and most of them were in the Breckenridge district. There may have been one or two wells in the western part of the state that we treated. We have treated wells in Texas, New Mexico, Kansas, Oklahoma, Louisiana and Arkansas, and we may have treated a few wells in Kentucky. We have treated one or two wells in Nebraska, and I think we have been into Colorado on a treatment or two. This list of well treatments was prepared under my direction. We kept that record of the wells we treated and it is a true record of the wells we treated.

Out of the numerous wells we have treated with acid for the various oil companies, I think we have received one or two complaints due to the corrosion of the iron in wells. I do not regard the use of an inhibitor as necessary to the successful treatment of an oil well.

In the Breckenridge district of Texas there are a number of oil wells, and in general the oil is produced from a lime formation. This field is approximately twenty-one years old, or a little over. In 1932 when we started to acidize oil wells the production of oil from the wells in this field was not as great as it had been in previous years. The production was down to the pumping stage and there was not over one or two wells flowing in the county. A number of the wells were being plugged. Our treatment of these wells with acid was very successful. We helped practically all the wells we treated. As a result the oil operators changed their plans as to what they did with their wells, and immediately after we commenced acidizing it was common practice that the wells be acidized before they were plugged. The acid treatment materially increased the production in this field, and in this district in 1932, I would say, we had anywhere from a two-barrel increase to a hundred-barrel increase per day for each well. I think some of the increases ran even higher than that, but that is just a picture of it.

In the territory where we operate, and have operated, the purpose of the acid treatment is to increase the production of the well. It is our intention that the acid react with the calcium carbonate in the formation from which the oil is produced.

CROSS EXAMINATION

The exact date of incorporation of The Chemical Process Company is October 12, 1932. With respect to the date of the first well treated with acid by The Chemical Process Company, or treated with acid by me and my associate Mr. West, we have two wells we originally treated that are not in the records. One was a well in Eastland County, which we found out later had a sand formation. The next well we treated on October 13, 1932. We treated that well, the Akers No. 1, with 730 gallons of acid.

Mr. West, my associate, and I learned of the acidizing business in 1932 from a couple of fellows, named Markham and Melville, who came here and wanted to make an experiment with acid. I never heard of Dowell Incorporated or The Dow Chemical Company having acidized wells prior to the time we started acidizing wells.

The Chemical Process Company employs a chemist and maintains a complete laboratory. In some cases it is the practice of our company to retain samples of the acid used in treating the wells. Without inquiring, I am unable to say if we have any such samples on hand at present.

We received one or two complaints from operators for whom we had treated wells. These complaints were received on account of corrosive conditions. The acid attacked some parts of the well, or at least the operator so alleged. That is quite common with every operator in the business, or every acidizing company in the business. They run up against things of that kind.

REDIRECT EXAMINATION

Since 1932 our business has increased from year to year. We have had some years that were larger than others, according to how the oil business was going. Of course, in some years there is lots more drilling than in other years. I can say this, that our business has increased in the amount of work being done every year and has grown generally all during these years. We only used an inhibitor on a few wells. We only used it between the time that suit was tried. The business has grown at all times, but we did not use an inhibitor after that suit was reversed.

Mr. Conner: I object to the entire deposition as irrelevant and immaterial. Do you want us to show Chemical Process infringes the Grebe-Sanford patent in order to prevail that Halliburton infringes? That is exactly the position we find ourselves in this morning.

The Court: If you have a patent that is going to apply to the man that just goes and buys the ordinary commercial hydrochloric acid and uses it without putting anything at all in, why all right. You have to show me because I don't think that your patent covers that. I don't think your patent ought to cover a man who just buys ordinary hydrochloric acid and uses it. That is the old patent of 1896, or whatever date it was. That is what he says he does, you have it right there. If you claim he did something else, you ought to prove it.

Mr. Conner: That is just what it comes to. It comes to one thing, and that is this: Do you want plaintiff, in order to prove the defendant infringes, also to show you that Chemical Process infringes?

The Court: I am not considering it on the question of infringement at all. I am considering it on the validity of the patent. Just that claim. It doesn't have anything to do with whether or not the defendant is infringing your patent. I don't see that it even squints that way. I don't see how any judge could possibly get out of that deposition

I have just heard anything about infringement of the patent.

Mr. Conner: I agree with you.

The Court: I am considering it entirely on the question of the validity of your patent.

Mr. Allen Owen: Your Honor, on the question of the validity of the Grebe-Sanford patent, as affected by the testimony of Mr. Pitzer, you, of course, appreciate it is not prior art against Grebe-Sanford.

The Court: Certainly. I am considering it in connection with why this thing has grown as much as it has, how much is due to the patent and how much is due to other things. That is what I am—

Mr. Allen Owen (interposing): You are considering it on the question of utility, then, of the—

The Court (interposing): No. You have brought into this case the revolution of the art by your patent.

Mr. Allen Owen: Yes, sir.

The Court: And I am considering it on whether or not that claim is true. That is what I am considering it on.

Mr. Allen Owen: In order to hold the Grebe-Sanford patent invalid, then, it would be necessary for Your Honor to find it had no utility; is that correct? In considering such testimony as Mr. Pitzer's.

The Court: You are invoking that well-known rule, and Judge McDermott made very great use of it, in taking a doubtful patent and saving it, because that has just torn the world all up and revolutionized the art. That is all he did. And it is a well-known rule that it is a proper thing to do for a patent that has done that. It is right close to the line, it looks as if it doesn't have any validity or wasn't good. That is what Judge McDermott says, at first blush you would think this patent was not any good, because you have just taken two patents and brought them close together. But he goes on and because this patent, by doing that thing, and bringing the two together, he reaches the conclusion that you have revolutionized the art entirely, and that this wonderful growth is due to this patent. And, if he hadn't, he never would have saved the patent. Now,

here is proof to be considered on that thing, as to whether or not you have this patent—this patent has accomplished this thing that will save a doubtful patent. That is all it is for. You bring in the claim and talk about what you have got in this patent, to save it, is that thing to take that out, and Judge McDermott would have beaten you in a minute, I can see that by reading his opinion, he starts right out by saying that.

But he finds that there is this wonderful thing that has been accomplished by the patent, and that is what saves it. Now, I am re-trying it, the very same issue, exactly, as near as I can see it, it is the same issue, but I have got some additional proof and this is some of it, as I understand it. Here is some proof that he didn't have that it is proper to consider.

Just like I suggested that I was going to be interested all along to learn what has produced this result, how much of it goes to advertising. In other words, suppose you had taken what now, on the face of it, this concern down there has taken, the raw acid, and made a pretty good business out of it.

Now, if Dow Chemical had taken the raw acid and gone into it and advertised it, and with their wonderful fine service that they give to everyone, if they had used that, how far would they have gone? Now, it is the difference between that measures revolution, how good the raw acid and how good a job that will do, and how good and how much is due to the new patent, that you have got to determine in reaching this revolution of the art. Now, I think I have defined the place that this has in the case, and it has nothing to do with infringement. I do not see how I would use it at all. I never thought of doing that and ought not to do it.

WILLIAM A. THOMAS,

a witness called on behalf of the defendant, testified as follows:

DIRECT EXAMINATION

I reside at Mt. Pleasant, Michigan, and have been a geologist for the Ohio Oil Company for two years. Prior to that I was employed by The McClanahan Oil Company and the Pure Oil Company. I left the Pure Oil Company six years ago. Prior to that I was in their employ for twelve years continuously as a geologist.

I had occasion to call on the Dow Company late in 1931 or early in 1932, with reference to a matter involving hydrochloric acid. In December of 1931 I had an idea that acid could be used on lime wells in the Greendale pool. I went over to Dr. Grebe, who was in charge of the research at Dow Chemical, and I might say I was introduced to Dr. Grebe by Ross Sanford.

Mr. Lyon: Before you go into the details of the meeting, I would like to ask you a few questions about the idea that you had before you went there. Where did you get this idea of introducing hydrochloric acid in a limestone formation? A. Being a geologist we quite often use hydrochloric in determining whether it is limestone or whether it is dolomite, and from the samples examined and from knowledge in elementary chemistry I was certain that hydrochloric acid would work on the limestone.

Q. Had you taken this idea up with anyone in the Pure Oil Company, any superior of yours, before you contacted Dow? A. I did.

Q. With whom? A. The chief geologist, Mr. Wasson.

Q. Tell us of your conversation with Mr. Wasson.

A. About one of the first wells drilled in the Mt. Pleasant or Greendale pool, we tried experimenting by use of a bit that would drill horizontally, and this bit was un-

successful and we discontinued it. And, through talking to Mr. Ross Sanford and to Mr. Dow, senior, he was telling me of the hydrochloric acid that they had at that time, and apparently was a drug on the market. In fact, they were neutralizing the hydrochloric with limestone, and that is really the way I got my first idea that we had hydrochloric and I wanted to drill horizontally.

Q. Now, was that idea your own idea or was it some idea that you had obtained from either Mr. Dow or Mr. Sanford or anybody else? A. That was my own idea.

Q. And had you communicated it to Mr. Sanford or Mr. Dow, senior, or anyone else in the Dow Company before you went over for this visit that you referred to a few moments ago? A. I had not.

Q. And before going over to the Dow Company you had communicated it to the chief geologist of the Pure Oil Company? A. That is true, yes, sir.

Q. Were you given any authority, or asked to do anything about the matter by the chief geologist? A. He suggested I would go to the Dow, and knowing Ross Sanford, I went to Ross, who, in turn, took me down to Dr. Grebe's office.

Q. Did the chief geologist suggest that you go to Dow for any particular purpose; if so, what? A. To get the price on hydrochloric acid.

Q. You had known Mr. Sanford before, had you? A. I had, several years, and he took me to see Mr. Grebe.

Q. And up to your meeting with Mr. Grebe had you told Mr. Sanford what you had in mind? A. I told Mr. Sanford what I had in mind and he suggested that I would see Grebe, in charge of the research at that time.

Q. Where was this conversation that you had at this time with Mr. Sanford before you saw Mr. Grebe? A. It was in the outer office near the information booth of the Dow Chemical. As near as I can fix the day, it was about December 20th, or the day before I wrote to Mr. Wasson.

I think the first inquiry I made of Dr. Grebe was the availability of hydrochloric, and he said that they had

plenty. I asked him at that time to tell me how much limestone that hydrochloric acid would dissolve. He had a young chap in the back, who figured out about fifty-six hundredths of a cubic foot per barrel of acid, that is, on 20 per cent strength. During the conversation I discussed the idea of applying this hydrochloric to an oil well. This was suggested by me. It did not come from any of the other people there.

Mr. Lyon: Will you continue and tell us what else, if anything, was said at that meeting? A. I do remember one thing in particular that Dr. Grebe said, that they had tried to acidize sandstone wells, and had built the pressure up high enough to raise the earth. Now, that is one thing that really did stick in my mind; theoretically they could have done it, but he said they naturally did not. I also asked Dr. Grebe to give me a price on carbon tetrachloride, because I was quite in doubt as to whether the acid would react on the limestone without washing the surface, or dissolving some of the paraffin off the surface of the limestone at the bottom of the well. He quoted me prices on that, and, in general, from about fifteen minutes to a half an hour I spent in the office, that was the gist of the conversation that I had with Dr. Grebe at that time.

Q. You stated that this young assistant of Dr. Grebe's worked out the amount of limestone that would react with calcium chloride? A. Yes. I have it in writing. He wrote this out himself, this calculation and gave it to me.

Q. I notice on the back is some brief notation. Will you tell me in whose handwriting that is? A. That is in my own handwriting.

Q. When did you write that on that paper? A. At the first conference with Dr. Grebe.

Q. What does this refer to, your own handwriting? A. It refers to the price of carbon tetrachloride; it weighed 13 pounds per gallon, and they would sell it to us for 7 cents per pound. Hydrochloric acid would cost us from 2 to 3 cents per pound.

(The paper above referred to was offered as DX-300.)

Mr. Sanford was not present during all of this conversation that I had with Dr. Grebe. He left the office after we started discussion. I was accompanied by a scout by the name of George Bell, scout for the Pure Oil Company. He is now superintendent of production of the Smith Petroleum out of Greendale, Michigan.

Mr. Lyon: Was there any other subject discussed that you recollect at that first meeting with Dr. Grebe? A. In general, I discussed the action of the acid on our tubing, or on our bailer, and realizing that some damage would be done I really discussed it because I told him we would use, probably, the old bailer or old tubing, and we would not put enough acid in the well to bring the acid level up to the bottom of the casing. We had something like 60 or 70 feet of open hole, and I really dismissed the action of the acid on the pipe at that time.

Q. Now, following that meeting, what was done about this proposition? A. For the next few days, I waited until I heard from our Chicago office, and I was instructed to go back to Dow to see how we could deliver the acid to the well, and I also asked Grebe if he would furnish a couple of chemists or a couple of men to take samples of our residue to see whether or not we got complete neutralization of our hydrochloric acid on the limestone at the bottom of the hole.

Q. And you wanted the chemists to do what? A. I wanted them to furnish me a chemical analysis of this residue to see whether or not the acid had spent itself, or whether we should leave it in the well longer, or if we had left it in long enough.

Q. And how were they going to get a specimen of that residue? A. Why, they would get that specimen from our bailer or from our tubing after we had applied the acid to the well.

The Court: Well, from our tubing, you mean down the inside? A. Down the inside of the well; yes, sir.

The Court: Pump it up or what? A. We could pump it up, or we could use the bailer and bail it up.

Mr. Lyon: Who did you meet on the occasion of that second visit, if you remember? A. I am not sure whether Ross Sanford was there or not. I couldn't be positive of that. I met Dr. Grebe, but I don't remember whether Ross Sanford was at the second meeting or not. I talked to Dr. Grebe.

The Court: You remember whether there was anyone else there? A. I do not. Because I knew Dr. Grebe at that time and didn't need an introduction.

Mr. Lyon: Do you remember now the subject that was discussed at that second meeting? A. Not in detail; no, sir.

Q. What transpired on this subject following that second meeting with Dr. Grebe?

The Court: Well, now, what was the response? You made a request for two chemists, did you say? A. That is right. And they furnished two chemists at the well.

The Court: All right. In other words, you got what you went after. A. Yes, sir.

Q. Now, how long after that second meeting was it before this operation at the well to which you just referred? A. Well, it was within two or three weeks. I can't give you the exact date.

Q. Can you tell us what the name of the well was? A. I believe it was Fox No. 5 in Section 13, Chippewa Township, Isabella County, Michigan.

Q. And tell us how the arrangements were made in your own company for that operation. A. I went to Dr. Grebe and suggested that we would either take it out in carboy lots or have them furnish a truck to take the acid to the well.

Q. That covers how the acid was to get there, but who made the arrangements as to the work that was to be done at the well outside of what these chemists were to do? A. The Pure Oil production department did.

Q. That was handled by the company's own men? A. Company's own men.

Q. Did Dow furnish anything except the acid and these two chemists? A. Not that I knew of.

Q. Were you actually present when the acidizing was done on the first Fox No. 5 well? A. I wasn't there when the acidizing was done.

Q. Were you present at any subsequent well when it was acidized? A. I was at the third well, Root No. 2 in Section 18, Greendale Township, Midland County.

Q. Tell us who furnished the acid on that well, who was there and what company's men did the work. A. The Dow Chemical Company furnished the acid and the Pure Oil Company did the work—that is, most of the work. They probably helped some on getting the acid there and helped the Pure.

Q. Will you state when, if at all, and under what circumstances there was first any discussion that you heard or participated in relating to the use of an inhibitor in the acid? A. The first time I heard of inhibitor was—I don't know whether it was on the third or fourth well, but it was after the well that I am speaking of. I knew nothing of the inhibitor until the Dow applied it to the acid that they furnished the Pure.

Q. Do you know whether or not the acid furnished by Dow for the first of these wells, the first few of these wells that were acidized by the Pure Oil Company, contained any inhibitor? A. As far as I knew they did not, but I didn't see whether they put an inhibitor in it or not.

Q. Now, just tell us what use was made of this acidizing process after this first well that you were on, the Root No. 2, from then up to June, 1932, by The Pure Oil Company, that you had knowledge of. A. From the third well, that is Root No. 2, most of the application and I might say the planning of putting acid into the well was done by the Petroleum Engineering Department, and I had very little to do from then on with anything having to do with acidizing wells. After the third well was acidized I had very little to do, if anything, with acidizing wells.

Q. You referred to the Petroleum Engineering Department. That was of the Pure Oil Company? A. Pure Oil Company. Mr. Carr is chief engineer.

Q. Now, subsequent to the treatment of that Root No. 2 well, some time after that did you learn of an argument between the Pure Oil Company and the Dow Company as to this acidizing process? A. Well, it was some time along in the spring that the Pure officials were aware that Dow had applied for a patent for inhibitor, and naturally the Pure was very much concerned and they took me over on a couple of occasions to meet with attorneys for Dow and with Grebe. Outside of one instance I wasn't permitted to be in on any of the conferences. I sat in the car at The Dow Chemical Company because they wouldn't produce Grebe and the Pure Oil Company didn't need to produce me.

Q. Did you have a meeting, were you present at one of the meetings, were you actually brought into one of the meetings? A. Not when Dr. Grebe was there; we went out to Willard Dow's home one afternoon for about an hour.

Q. And you say "we," who accompanied you on these visits, or attempted visits? A. Mr. Plummer; he is assistant superintendent of production for the Pure Oil Company; Ed Clagett, manager of the Michigan Division. I don't remember who else was present at that time.

(Here DX-301 and 302 were offered and received.)

The Court: What do you say, Mr. Thomas, about the first you heard about inhibitors? A. Well, it was, at the time I talked to Dr. Grebe and Ross Sanford on the first occasion, I asked them about the action on the pipe, or we discussed that.

The Court: Yes. A. But I dismissed that at that meeting, saying that we were going to use probably the bailer or going to use tubing that it would not hurt if it did affect the pipe, so I didn't pay much attention as to whether or not Mr. Sanford spoke of this chromate. I do not remember it.

Mr. Owen: Do you know whether they did use a bailer at that first treatment? A. I was not at the first well.

Mr. Lyon: What did they use on the Root No. 2 well which was the first one you were at; did they use a bailer or tubing? A. They used tubing, if I remember correctly.

The Court: What is the first memory you have about hearing about inhibitors? You are not sure whether you heard about it at that first meeting, because, as I understand it, you weren't very much interested in whether it ate the pipe or not, because the situation was such you thought it wouldn't eat it. Wouldn't get at it. A. I knew it would eat it, but I didn't think it would hurt it.

The Court: Was it going to be in the acid? A. It wouldn't be in the acid very long. You see, it would just be getting it in the well and getting it out.

The Court: And, after all, while it was in there, you mean, you didn't think it would be in contact. A. I thought our casing was set high enough in the well that it wouldn't get at the bottom part of the well.

The Court: You thought it wouldn't hurt going down and coming up. A. If it did, it wouldn't hurt very much.

The Court: All right. Now, you aren't real clear what was said about inhibitor right then, as I understand; is that right? A. That is correct.

The Court: Well, was the subject up, can you tell me whether or not you discussed acid and its effect on iron and you remember the statement that it wouldn't hurt in your well you didn't think; is that right? A. That is right.

The Court: But you don't remember, as I understand you—don't let me lead you at all—it is my understanding of it you aren't sure whether something was said about if it was going to be in contact with the iron very long it could be protected by the inhibitor? A. No, sir. I wasn't enough of a chemist so I didn't pay much attention to the discussion between Grebe and Mr. Sanford.

The Court: Now, when was the first that you heard them talk about an inhibitor that would prevent the hydrochloric acid from eating the iron? A. About the first I heard of it was from Mr. Carr and he was aware that the Dow had made application for patent for inhibitor.

The Court: And that you say was when? A. I can't give you the exact date. It was some time after.

The Court: You don't know now, I suppose, when they

said they had made application, you don't know whether they talked to their lawyers about it, whether it was actually filed. You would have no knowledge of that kind, would you? A. No.

The Court: Are you clear whether they had applied or were going to apply, any notion at all in between those two? A. I didn't know for certain whether they had applied or whether they were going to apply.

Mr. Lyon: I might state this, if it would be of any help, Your Honor. We do not believe we can unscramble any question here as to whether Grebe and Sanford or whether the Pure Oil Company were the men that first suggested the use of the inhibitor. So we are not going to raise any question about the inhibitor. The point I want to make clear to Your Honor is that this proposition of acidizing a well, call it if you want to a revival of the Frasch patent, wasn't the Dow Company's idea but the Pure Oil Company's idea.

The Court: Do you know how successful it was? You weren't there. You must have heard. You were interested in it. How did it come out? Or were you going to ask that later? I am curious to know how your treatments came out. A. On Fox No. 5, a well making about 3½ barrels a day, and we were ready to abandon the well any way—that was primarily the well we were given to experiment on—after the introduction of this acid it seems to me our production was doubled, or about eight barrels a day. We were still in a quandry as to whether or not it was cleaning up the hole or whether it was the use of the acid at that time. So we took another well. I can't recall whether it was the Thompson well, but our second well to the north in Section 12, was making about 30 barrels a day. We pulled the liner out of the hole, introduced this acid, and the production was stepped up to about 125 barrels a day. Then the third well, the Root No. 2—

The Court (interrupting): What do you mean by "the liner"? A. We had an open hole from the Traverse down to the top of the Dundee about 600 feet. The shale

was falling into the hole. We run a thin pipe in there to keep this caving from going to the bottom of the hole.

The Court: You call that pulling the liner out? A. We pull it out.

The Court: That is, the one you had in there? A. Yes, sir, and cleaned up the hole, and introduced the acid.

Mr. Owen: May I ask whether you pulled the tubing on that? A. Undoubtedly we pulled the tubing in order to get our liner out. We would have to. On Root No. 2 that came in initially for 700 or 710 barrels a day.

The Court: That would be the third well? A. That was the third well. I recall the production at the time we acidized it was about 90 barrels a day—that is before acidization. After the first twenty-four hours it made 790 barrels a day.

The Court: Was the casing in that? A. Yes, the casing was in it.

The Court: Did you take the casing out? A. No, the casing was in but we had no liner in that well.

The Court: The iron casing was in? A. Yes, sir.

Mr. Owen: I think you mean tubing, Your Honor, instead of casing. A. The tubing is removable, the casing is permanent.

The Court: In that second well, was the casing in? A. Yes, sir, the casing was in the second well.

The Court: So the acid came in contact with the iron as it went down is what I am after. A. Yes, sir, I would say so.

The Court: In all of these? A. In all of the wells.

The Court: You see, I had in mind your contention here that if you leave the iron in it doesn't do so good a job of acidizing the well down there in the rock is what I am thinking about. I didn't see how you could take the casing out but you didn't anyway. A. That is true.

The Court: When you took the liner out that left it so the acid went against the casing. A. No, Your Honor, the liner was placed in the open hole above the top of the Dundee. These wells were cased a little bit differently

than we case them today. Our present casing program is to run the pipe from the ground down to the top of the Dundee. In the early days of the Greendale pool we would set our pipe above the Traverse 600 feet above the Dundee, and there was some loose shale in some of the wells that would cave in the hole. In those wells we would set in 300 or 400 feet of liner in there.

The Court: Down below your casing? A. Yes, sir.

The Court: And you would protect that down in there? A. Yes.

The Court: But you didn't take the casing up, but the tubing. A. Second one.

The Court: What about the Root No. 2? A. The Root No. 2 as I remember was the first well we used oil on the outside and on the inside of the tubing in the casing. We filled the hole completely full of oil.

The Court: You don't mean outside the casing. A. Outside the casing, between the tubing. Then our acid followed down the tubing.

The Court: There you had your iron? You had your iron casing? A. Yes, sir.

The Court: You handled it just as you would if there had been an inhibitor in so far as the iron is concerned, so far as the acid coming in contact with the iron? A. Yes, sir.

The Court: You didn't do anything to protect the iron from the acid in the Root No. 2? A. That is true.

The Court: How was the situation as to whether it was a well where it was likely to get in contact, like in Fox No. 5 the situation was such that even though you didn't have any inhibitor in the acid wasn't likely to be long in contact with the iron. What in that regard was the situation in Root No. 2? A. I can't recall, Your Honor, whether they were as careful on Root No. 2 as they had been on the other wells or not.

The Court: It wasn't a case of being careful, as I understood it. It was more a case it happened to be the iron wasn't down in the well on Fox No. 5. A. That is

true. I might add on the first well we were going to junk the well anyway. It didn't make so much difference. Here we had a well making 90 barrels a day and we were a little more careful of spoiling that well.

The Court: Now, the fourth well, tell me how that came out. A. Each well after the first three we had a noticeable increase in production.

The Court: You had a noticeable increase in number 3 I would say. A. From then on we never did have a failure in acid that I recall.

The Court: No. 4 didn't have any inhibitor in it? A. I can't say as to the inhibitor.

The Court: What about No. 1? A. I don't know whether they put an inhibitor in it, or not.

The Court: All right.

Mr. Lyon: Did you order any inhibitor for that well? A. I did not.

Mr. Owen: Did you have charge of the ordering of the acid? A. I had charge of ordering the acid from Dr. Grebe. He said he would get the acid out there. Whether he put in an inhibitor, I don't know.

The Court: Did they charge you for the first well? A. I don't believe they did, because, as a matter of bookkeeping, Dr. Grebe suggested that they would furnish the acid free of charge, and it would save them a lot of bookkeeping; whether he charged the Pure Oil Company, I don't know. He made that suggestion that they would take it out there and charge it up to research.

The Court: How long were you in his office? A. I was in his office from fifteen minutes to a half an hour.

The Court: Your contention is that—I take it that you do not dispute that this witness right here, for the Pure Oil Company, went there to get the well treated—is that right? Do you dispute that? That they took the initiative in that regard? Is that disputed at all?

Mr. Owen: No.

The Court: That this witness went there for the Pure Oil Company and told them that they wanted a well treated, that they had made up their mind to make a trial—

Mr. Owen: I don't know whether they had gone that far; I don't think they had. I think they had it in mind. May I ask Mr. Thomas this question?

The Court: Yes.

Mr. Owen: Did you know of Mr. Sanford's activities in putting acid down their brine wells? A. I did not.

Mr. Owen: You didn't know anything about that? A. No.

The Court: He had not even inquired for him, as I understand it. He was introduced to the doctor. A. Oh, I asked Ross Sanford who I should get in touch with. He was the only man I knew, outside of Mr. Dow, Senior, and Mr. Willard Dow, at that time.

The Court: You had two things in mind to buy when you went there? A. Yes.

The Court: As I understand you? A. Yes.

The Court: Just see if I understood you right. You went there for the sole purpose of buying hydrochloric acid, and carbon tetrachloride to take off that sticky stuff off limestone? A. That is true, sir.

The Court: You got some information as to what you were going to buy, how much you would need to dissolve a certain amount of limestone? A. That is true.

The Court: Now, were there any other than those three things that you went there for, that you went there to get? One was information as to the quantity you would need, and the other things you had in mind were the two articles you talked about? A. Yes.

The Court: Did you notice anything—or, did they advise you as to what this would do? Were you the one that suggested what would clean their rock? A. I asked the question—I knew that carbon tetrachloride was a good solvent for paraffin, and I asked him if he knew of any better solvent at that time, and he said he thought the carbon tetrachloride would be all right. He gave me a price on it, which I thought was a little bit expensive, so I suggested the using of a sinker or something to splice part of it at that time, but I had not—other than that, I went there

for a price on the carbon tetrachloride and hydrochloric acid.

Mr. Lyon: What did you say about the hydrochloric acid, how did that come out? A. I asked them if they could furnish hydrochloric acid, and at what price they could furnish it to the Pure Oil Company.

(At this point DX-303 was offered and admitted.)

The Court: Now that is the first conference; how do you fix that date? A. About a day or two before the 21st; I think it was the 20th.

The Court: How do you fix that date? A. It was very forcibly fixed in my mind because they had taken me over to see the Dow several times, three or four times, and I never got into conference to tell my story.

Mr. Lyon: We are talking about the first meeting when you went to see Dr. Grebe and Dr. Sanford? A. Yes, that is December 21st, 1931.

The Court: How do you fix that? A. It was fixed very easy in my mind because we went over there so many times to see them and that date was the first letter I wrote to the chief geologist of the Pure Oil Company.

The Court: Have you got that letter? A. The letter was left when I left the Pure Oil Company, in the geological file at Saginaw, Michigan.

The Court: Did you write them before you went over there or right after? A. I went to Dow and the next day I wrote the letter to the chief geologist as to the price of this carbon tetrachloride and how I suggested handling it.

The Court: If you had that letter it would help you fix it, but now your memory about a letter is just as liable to be mistaken as your memory of this, I mean— A. That is true.

The Court: The thing you fix your date by, I haven't got, is the point.

Mr. Lyon: As I understand it, when you were having these meetings with these attorneys, and so forth, in 1932, you fixed that date very definitely from looking at that letter? A. I did, sir.

The Court: Oh, he did have it at that time? A. I did, yes, sir.

Mr. Lyon: Now, in connection with that statement of Dr. Grebe's that on that first meeting you had Mr. Humphrey with you, I believe you have testified that that was a mistake; you did not have Mr. Humphrey? A. I had just Bell with me on the first conference. Not Mr. Humphrey. Mr. Humphrey may have been there on the second or third conference. Humphrey was there at the second meeting, not the first. He had me mixed up with Mr. Humphrey at the first meeting.

Mr. Lyon (reading from DX-303): "Humphrey had made some laboratory tests with samples of oil rock from the Dundee structure in which he had shown that hydrochloric acid would dissolve the rock." You had, had you not? A. Yes, sir.

Q. And you had done that before you went to this meeting? A. Yes, sir.

Q. Before you had talked to Dow or ever heard of Dow making any suggestion about using hydrochloric acid in an oil formation? A. I had examined thousands of samples where we had used hydrochloric acid on either limestone or dolomite up to that time.

The Court: For what purpose? A. In our analysis we can more or less tell from the effervescense whether it is a dolomite or whether it is a limestone. In the field out there we can tell more or less the difference between the Monroe formation and the Dundee formation.

Mr. Lyon: Now, we have a stipulation that it had not been used on any of the brine well treating jobs. It is only a couple of paragraphs, Your Honor (reading): "Mr. Richmond: I offer this stipulation. It is hereby stipulated by and between the parties to this litigation that in all of the work done by The Dow Chemical Company or anyone in its employ or on its behalf prior to February, 1932, no inhibitor of any kind, nature or description was used in connection with the acid used in the treatment of brine wells, and the reports and records of The Dow Chemical Company so show.

"Mr. Owen: The proposed stipulation is accepted."

Mr. Lyon (continuing reading from DX-303): "Grebe states that he described in some detail to Thomas and Humphrey the work that we had done on brine wells in attempts to increase brine production and also for brine disposal through pumping back into old wells." Was that before or after you had told them you were interested in getting hydrochloric acid to introduce into oil formations? A. That was after I asked him for the purchase of this acid and carbon tetrachloride. He made a mention they had tried it out on the standstone wells.

Q. You had already told them you wanted it for penetrating the oil formation? A. Yes, sir.

Mr. Lyon: Now I want to show Your Honor the proposed first write-up for the Grebe-Sanford application. It was written up June 7, 1935. I have it here.

(Here DX-304 was offered and admitted.)

Mr. Owen: That was never signed or sworn to by Dr. Grebe, and never filed with the Patent Office, and the claim that counsel read covered Grebe and Sanford's work on brine wells. If I may at this time I would like to call the attention of the court to another document which counsel found in our files, and which he has not called attention to, and that is the affidavit of Mr. Robert J. Quinlan, which is dated December 5, 1932, Your Honor.

Mr. Lyon: I do not believe that Mr. Quinlan's affidavit is admissible. It is self-serving, and Mr. Quinlan is available right here.

Mr. Owen: It is not self-serving. He is not in our employ.

Mr. Lyon: He is available here. He was in their employ at the time this was written.

Mr. Owen: This is just as much admissible in this record as the other ones that you got out of our files.

Mr. Lyon: No, it is not. We can offer documents that we obtained from their files, but they cannot offer statements of men who were in their employ, who are still alive, and within the jurisdiction of the court. We asked them

before to produce Mr. Quinlan, if they want to rely on this document.

The Court: That letter you read from the Pure Oil Company I don't consider as proof of the things stated in it because I think, while not as to you, as to the Pure Oil it was a self-serving document, and I had that in mind at the time, but I do think it helps show the rabbit tracks, as I talk about, and for that reason it is admissible.

Now, I think this is self-serving, and all of these things that they found there in your office; there may be admissions and they are admissible for them, but I think from the other standpoint they are not proof any more than that Pure Oil Company letter is proof of the things stated in it. I do not think it is. I think it is self-serving. It was held in your office, but I do not think that is proof against you, because there you could not help receiving a letter, and that is self-serving so far as the things stated in it are concerned.

Now, here it is proof that you were in a squabble with them, and then the contract you made may be proof that you thought pretty well of those self-serving declarations they made. Now, you can offer this, one of your own employees, you go and get his affidavit after this squabble is on, I think that is self-serving; you could not offer it in any court, because when they go and find an admission there is lying along beside it a self-serving document doesn't admit it. I do think maybe it will be useful in these tracks again. Here I have got a new track way over there, whether it is the same rabbit or not again, this one is over June 7th, and the last track I have got here is way back quite a long time earlier than that. Now, I find way over in June 7th this unsigned—it isn't an application for a patent, but it evidently was in somebody's mind that it might be, dated June 7th. I think this affidavit may connect up the tracks to that now. So, on that theory I am admitting it, but not as proof of the things stated in it. I am not accepting it as true, but it may help me trace down here this thing, but if you want to prove that this thing is true you will have to call him as a witness. If he was dead,

beyond the jurisdiction of the court, that raises still another question, and the rule is being very much broadened in that regard, but I don't know of any broadening in this regard, the witness right here, a few miles of here, that an affidavit he made for his own boss a few years ago can now be brought in and used instead of his testimony to prove that.

But, I am admitting it as showing this chain of things that led down through to the patent in suit.

The Court: That makes me think what the Patent Office does to us. Now, he could not put that in his tank, he could not take an iron tank and put an inhibitor in and haul it out there without infringing their patent, so he had to go and get a wood tank and carry this in his pocket and put it in after he got out there. That shows what the Patent Office will do to business if you will let them have their way about it.

Mr. Owen: First he went and got the arsenic and then he went to the hydrochloric acid plant and put in 19 inches of water and then he ran into the tank 17 inches of strong 33 per cent hydrochloric acid.

The Court: And if the defendant's patent is any good he had to get a wood tank to haul it out there, isn't that right?

Mr. Owen: That is right.

The Court: That is what sounds so ridiculous to me.

Mr. Owen: That is what they claim.

The Court: Yes. The Patent Office, where they get business—there are people going out there to do their work and they could carry it perfectly all right in an iron tank, but they have to go and get a wood tank to get out there or else carry their inhibitor in their pocket and eat up their iron tank and put it in after they get out there.

Mr. Lyon: Of course according to the plaintiff's patent we would have to get a rubber hose and put it down an oil well.

The Court: Yes, these two patents split business across the grain instead of along the grain, hitching on improvements, it runs right cross grain and inconveniences and

divides it all on the road it would naturally travel through business. You can see right here you have got it split cross ways, and you go and get a wood tank to haul it out when they didn't need a wood tank at all.

(The Quinlan affidavit above referred to was thereupon offered and admitted as PX-305.)

Mr. Lyon: I understand that that is not received except for the limited purpose Your Honor indicated?

The Court: Yes, not proof of the things stated in it.

Mr. Owen: I might say in that connection, in the Williams Brothers record Mr. Quinlan was a witness called by the defendant and he testified substantially the same as he has here.

Mr. Lyon: That part of the Williams Brothers record is not in evidence here either.

The Court: So long as he is available, without stipulation, but they evidently want a chance to cross-examine him, and where a witness is right nearby, I think the court should give them that right to cross examine, and here is a witness that is easily available and because he previously made affidavits or gave testimony, I hold it is not admissible as proof of the things he said, but I do admit it. I will look at everybody's testimony out there in the Tenth Circuit for the purpose of interpreting those opinions out there, so in that way we do look at things.

CROSS EXAMINATION

By Mr. Owen:

Q. I did not quite understand, Mr. Thomas, whether you were claiming that you personally were the one to discover that hydrochloric acid would dissolve limestone, and to suggest the use of hydrochloric acid in an oil well for that purpose? A. As far as I knew, no one had ever tried it before, and it was my own idea that we should try it out there in the Greendale pool.

Q. Did you ever file an application for a patent on it? A. I did not.

Q. Did you know that others connected with the Pure Oil Company had filed applications relating to the method of treating oil wells with acid? A. I knew that Mr. Carr was working on what turned out to be the Carr patent, along in the first part of 1932, yes, sir.

Q. Did it occur to you then that you should file an application on your own idea? A. Well, since I was working for the Pure Oil Company, I was given to understand that anything I found was theirs.

Q. Did they ask you to file an application? A. They did not.

Q. After the first talk with Grebe and Sanford, which you fix as on or about December 21, 1931, what, if anything, did you have to do with securing the consent of the officials of the Pure Oil Company to make a treatment on one of their wells? A. I wrote a letter to Mr. Theron Wasson, who was chief geologist for the company, and he, more or less through his suggestion, got Mr. Carr interested in trying out the treatment of this first well.

Q. Did you discuss it with Mr. Carr in any way? A. Not until after I had written the letter to Wasson; I told him of my ideas, and he said to get that in writing, and get the price of acid and tetrachloride, "And I will see what I can do with the Chicago office."

Q. Did you discuss it with them, with any of the officials or any of your superiors in the Pure Oil Company, before the first treatment was actually made? A. Well, Mr. Humphrey then came into the picture; Mr. Humphrey worked for Carr, and he came into the picture, oh, within four or five days, or a week, and we went over to see Mr. Grebe then together.

The Court: That is the second visit? A. Yes.

Q. And at that time, at that second visit, was anything said about protecting the well tubing and equipment by the use of an inhibitor? A. I don't recall the inhibitor as much as I did on the first talk with Grebe, because Mr. Humphrey did most of the talking on the second visit and I was more or less a listener.

Q. You do recall that on the first visit in December, 1931, Dr. Grebe did suggest the use of an inhibitor? A. I do remember this, that if there was anything brought up on an inhibitor I told him I wasn't so much interested because we were going to use an old bailer and tubing.

Q. And you do not claim to have had anything to do with the suggestion of using an inhibitor? A. I do not claim it.

Q. You did not know they were using an inhibitor until after several treatments had been made? A. That is true.

HOWARD M. NICHOLS,

a witness called by defendant, testified as follows by deposition:

DIRECT EXAMINATION

By Mr. Babcock:

I reside at 102 Henly Road, Overbrook Hills, Pennsylvania, am manager of a refinery of the Atlantic Refining Company, and am over 21 years of age. I knew John W. VanDyke, who in about 1895 resided in Lima, Ohio. We were related by marriage. Mr. VanDyke's wife and my mother were sisters. I lived with him when my mother died, ever since 1891. I was acquainted with a party by the name of Herman Frasch. I did most of the driving and

hauling with the team of horses, and as Mr. Frasch would visit Mr. VanDyke I would go sometimes and meet him and drive him to the refinery or take him where he wanted to go. I first knew Mr. Frasch about 1892. Mr. Frasch was a German and Mr. VanDyke was a Pennsylvania Dutchman. At least, that's what he used to call himself.

I have every reason to believe Mr. Frasch was at that time the chief chemist of the old Standard Oil crowd. I believe he was well educated. He is now dead. Mr. VanDyke also is dead. He died September 23, 1939. They were both interested in the acidizing of oil wells. As I said before, as a youngster in those days I drove Mr. Frasch and Mr. VanDyke about a great deal with our own horse and carriage, and I have driven outside of Lima when they were experimenting with those wells. I went with Mr. VanDyke sometimes two or three nights a week, sometimes every night, sometimes with Mr. Frasch. I have one very good recollection of one of the earliest instances of Mr. VanDyke's acidizing of wells, and that's when he made a bet of a Dunlop hat that he could increase the production of a well by, I'll say some ten or fifteen barrels a day. He was successful in it and he won the bet. I don't know whether you remember it in those days or not, but a Dunlop hat had a label in it which was easily extracted. I took it out and pasted it in a hat which was not a Dunlop hat, and I was proud of the fact. The old gent saw it and he wanted to know when I was buying Dunlop hats. I told him I had taken it out of his, and he gave me hell for trying to be somebody that I wasn't. I got quite a lecture on that. That was an incident in my life that was connected with acidizing of wells, as there were times when some of the old gent's lectures were followed by other things.

As to how extensive the work was, I know that there were in the surrounding territory other people; there was a Mr. Channing Lufkin who was a neighbor of ours in Lima, who I think was connected with the Ohio Oil Company at that time. He had a brother or something, Elgwood; his

son was president of the Texas Company for some time. They are both dead. I know Mr. Lufkin was interested in it because he used to come over and they would sit on the front porch and talk about it. Personally, of course, at that time I had no interest in anything at all, except, you might say, playing stable horses, but I know that work continued over a period of a year or more anyhow. It was around I think 1895 and 1896, as I recall it. I didn't move away until 1898. I'll tell you when that was, that was right after the Spanish-American War. I don't know any of the details of the work that was done there. I mean, for example, what kind of formations they were trying to treat.

The material used in the process was some kind of acid. I knew of at least two or three wells that were treated but beyond that I have no recollection. I was born in 1881; that would be 15 or 16 years old, around that, in 1895 or 1896.

I was out on a well while that well was being acidized by either Frasch or VanDyke or someone under them. I remember this much, when they first started to try to get acid down the well, they had a lot of difficulty. I think first they tried to pour it out of a carboy; then they started to pump it. I do know they had some trouble with the pipes eating out. I have no recollection as to whether they remedied that difficulty or not, only by the old correspondence, which I have referred to lately. I first saw it less than two months ago when it was revealed in Mr. VanDyke's file, I think it was after a visit that you (Mr. Babcock) made here, and I had told you what little I knew about what part I had played with Mr. VanDyke and Mr. Frasch. After Mr. VanDyke died there was this bundle appeared and his secretary, Miss McKain, handed it over to me. I think she is in this building now. Of the papers in this file I can positively identify Mr. VanDyke's signature, and I am pretty sure I can identify Mr. Harper's signature, because I worked in the refinery for some years when Mr. Harper was there, and I knew him very well. In fact, I worked in the shop right with him. He was the boss pipefitter. In-

dependent of this file I know that he did all the pipe work in connection with this work of acidizing oil wells, connecting them up out at the well. Morris was his first name; I never recalled his second name. M. G. were his initials.

I would hate to swear I would recognize Mr. Frasch's signature, but I believe I could pretty near pick it out. I remember Mr. Lufkin and could identify his signature if I saw it.

Mr. Babcock: In the file which the witness has just been referring to, I find a letter addressed to J. W. VanDyke, Lima, Ohio, and signed by M. G. Harper, this being two pages. It was marked DX-72.

(The witness examined DX-72 and continued):

I would say that was Mr. Harper's signature. I might say this in connection with some of the signatures, particularly Harper's, that I kept a division of labor book in the Solar Refining Company as a youngster, and I had occasion to—everything that happened with the pipefitting gang always had to be signed by Mr. Harper.

(The witness examined DX-73 and testified):

My own name is on there. It is not my handwriting. That is Howard Nichols that appears in there.

(A memorandum on the stationery of the Ohio Oil Company signed "C. F. Lufkin" was marked DX-74.)

(The witness examined DX-74 and testified):

That looks very familiar to me. I believe that is Mr. Lufkin's signature. I have seen that many, many times.

(A letter dated December 16, 1895, addressed to Mr. J. W. VanDyke, Lima, Ohio, signed "M. G. Harper" was marked DX-101.)

Mr. Babcock: On this exhibit are some pencil markings and also some writing in pen. I will ask the witness to state what he can with reference to that handwriting. A. This is all Mr. VanDyke's writing here (indicating). This part in pencil is in Mr. VanDyke's writing.

Q. Will you read there what you can of the writing in pencil. A. McCarthy was the superintendent at Lima, Ohio. "Mr. McCarthy. This one-inch pipe should take

two coats of paint." The other one is "McCarthy: Please tell the shipper to—" he wanted something charged to him, anyhow.

Q. I will ask the witness if he can identify the signature in ink on that letter. A. It looks very much like Harper's signature written in a hurry.

CROSS EXAMINATION

By Mr. Conner:

I am now manager of the Point Breeze refinery of the Atlantic Refining Company and have been since 1921. I have had very little experience in connection with the production, casing and drilling of wells, except as a boy during the summer I pumped three wells out on a small farm that Mr. VanDyke was interested in, known as the Lininen Farm in Ohio. That was around 1894 or '5.

Mr. Frasch and Mr. VanDyke were both interested in acidizing the wells I referred to. They were working together. I was present when acid was put in some of these wells. That was in 1895 and 1896—about that time. I was about fifteen at that time. I was going to grammar schools and was not familiar with chemistry at that time. I know it was an acid that was put into those wells. They got the acid in carboys. We had an acid restoring plant at the refinery at Lima. I knew in a general way what acid was and how it was handled. I think it was sulphuric they used in those wells; that's what they handled at the refinery, I think; that's what they started with, I think. I have seen carboys there at the well site. I assume there was acid in them. Carboys was the way we handled acid in those days; big glass bottles in square cases; and they had a—I don't know what kind of cork it was—like a mushroom.

Mr. Conner: Do you recall now how the acid was put into the well? A. I think I know. They pumped it in. I know they tried to pour it in to start. Beyond that, I don't know.

Q. Do you know of any preparations they made at the

well relative to preparing the well prior to putting the acid in? A. No.

Q. Then the only acidizing or treatment of wells with acid that you have knowledge of occurred only during the period of 1895 to 1896, is that correct? A. Yes.

Q. How many wells in all did you witness? A. About two or three, near Lima, Ohio. Some of them were out of the state, I think, or farther away from where we would normally drive to. I didn't witness them in any other state.

Q. I think on direct examination you testified to the fact that the lines or the pipes were eaten up by the acid. Will you please explain that, as you recall it? A. Well, I know they were eaten up because they had some difficulty with the lines. I will say this, part of that information come from reading it here, on the rubber coating and these—

Q. What lines were you referring to as having been eaten by the acid? A. I wouldn't like to say; I don't remember.

Q. Where did you get the knowledge that you gave on direct examination that certain lines or pipes were eaten by the acid? A. Probably from hearsay.

Q. Do you know what if anything was done at that time or subsequently to remedy the attack of the acid on the pipes or those lines? A. Only from what I notice in the files.

Q. What is that? A. Rubber coating and painting with various asphaltic paints.

Q. You testified this morning to numerous exhibits on direct examination which were obtained from a file. When did you first see that file? A. About two months ago. It was after Mr. VanDyke's death, when they were going over his papers. They brought it out. Prior to that it has never been in my possession. I have never been responsible for its safe keeping.

Q. Did you ever receive any letters from Mr. Frasch? A. No.

Q. Did you ever see Mr. Frasch's signature? A. I

probably have, but I wouldn't swear to it, I wasn't familiar with it.

Q. When did you last see Mr. VanDyke, can you state that? A. It was this year; it was around August, 1939; the early part of August of this year.

Q. Mr. VanDyke died in 1939, did he not? A. Yes.

Q. Had he been active in his business up to that time? A. Yes. The last few months he was taking treatments at the hospital for his throat. He had been coming into the office off and on. He was away; the early part of 1939 he was away at the hospital for I think about 114 days, at one stretch.

Q. Did you ever see Mr. VanDyke sign his name to any papers? A. Yes, lots of them. I would recognize his signature. I could also identify Mr. M. G. Harper's signature. I last saw Mr. Harper sign his name in around 1897; 1897, 1898.

Q. Such signatures of Mr. VanDyke as you have identified this morning, when were those signatures made? A. They were all made in around 1895 or '6.

Q. Have you seen Mr. VanDyke's signature since those days? A. Yes.

Q. Have you seen Mr. VanDyke's signature continuously from that time on? A. Right up until now; I have watched it change in its various characteristics.

Q. With reference to these several wells that you said you were present when acid was put into them, will you please explain just what is your complete knowledge of what was done to those wells with reference to not only what was done, but what materials went into those wells? A. Well, my presence at the wells was not as a worker, but as a horse and buggy chauffeur, and therefore I couldn't help but observe and know what was going on because the big chief was always telling me things of what he was doing and what he was trying to accomplish and they were trying to accomplish, increasing the production of the wells by putting acid in the wells to eat the formation, to open up cracks and fissures to let more oil out. I have never made use of that knowledge.

Q. Then you were associated with Mr. VanDyke from the time you were about 15 years old, is that correct? A. No, longer than that. I went to live with him when my mother died in 1891.

Q. Do you know what various parts he may have played in the petroleum business during his lifetime? A. Lots of them.

Q. Do you know whether or not he was ever chairman of the board of the Atlantic Refining Company? A. Yes, sir. He was chairman of the board from 1929 back before the last war, the World War I think. I don't know the exact dates.

Q. Do you know whether Mr. John W. VanDyke was ever president of the Atlantic Oil Producing Company? A. Yes, I think he was president of all of our subsidiaries.

Q. Do you know whether he was president of the Atlantic Oil Shipping Company? A. I say, I think he was president of all of our subsidiaries of which that was one.

Q. Do you know whether he was ever president of the Keystone Pipe Line Company? A. I think so.

Q. Of the Atlantic Refining Company? A. Yes.

Q. Of the Venezuelan Refining Company? A. Now, you are getting into a lot of subsidiaries. It is none of my business—in other words, I wouldn't know much about them.

Q. Of the Buffalo Pipe Line Company? A. I think he was president of all of them.

Q. Do you know whether he was a member of the American Petroleum Institute? A. Yes.

Q. Will you explain, please, Mr. John W. VanDyke's connection, if any, with the Standard Oil Company? A. Well, he was with the old Standard Oil group before the Solar Refining Company was ever built. In fact, he was sent out there to build it. That was at Lima, Ohio. In 1903 he came on here. He was on the managing committee at 26 Broadway while he was general manager of the Solar Refining Company.

Q. What was the proportion of Mr. VanDyke's life

span during which he worked or was engaged in the petroleum and oil business? A. I think about ever since he was 19 years old until—he would have been 90 if he had lived another two months.

Q. Did his association with the oil business entail all of the various branches of the oil business? A. I think he touched pretty nearly all of them throughout his career, including production, refining, marketing, shipping, financing; the whole bag of tricks.

Q. From your association with Mr. VanDyke would you say that he was fully cognizant of the various production problems that arose during his lifetime? A. Yes, sir.

Q. Do you know why Mr. VanDyke employed this acid in these wells at the time you testified about, back in 1896 and 1895—what was his object in using that acid? A. The object of putting the acid down in the wells was to eat the rock formation which I believe around Lima was limestone formation, in the hope that it might eat larger fissures and probably also, those created after a shot of nitroglycerine, have the acid go back to eat a larger crevice in order to admit more oil in the well.

Q. Then he was trying to get more oil out of the well? A. Yes.

Q. Do you know of any other ways in which Mr. VanDyke treated wells in order to increase their production? A. No.

Q. Do you think that if he had done any extensive work other than that directed toward the increasing of the production of wells, you would have known about it? A. Not as a co-worker, but simply as an associate, as one member of the family.

Q. Will you please explain what, if any were your associations with Mr. Herman Frasch during his lifetime? A. Well, only that of a boy, a member of Mr. VanDyke's family.

Q. Do you know whether Mr. Frasch ever did any work directed towards the production of oil from the Ohio oil fields? A. Only in connection with Mr. VanDyke. That is all the knowledge I have of that.

Q. Other than that which you have testified to here this morning concerning the work of Mr. Herman Frasch and Mr. John W. VanDyke, what if any other knowledge do you have concerning these men which would throw light on their attempts to treat oil wells with acid to increase their production? A. I think Mr. Frasch probably got the hunch, as you might call it, from the pumping of superheated steam down the sulphur mines or sulphur wells in Louisiana, and pumping the molten sulphur out. I think he did the same thing with the salt wells up around Cleveland.

Q. That, of course, did not concern the problem of producing oil? A. No, but it did give an indication of which way his mind was working.

REDIRECT EXAMINATION

By Mr. Babcock:

Q. I would like to ask the witness if he knows William Irish. A. Yes.

Q. Will you please state where you first met him and how long you have known him? A. No, I presume Mr. Irish has known me more than I have known him. He knew me when I was born. I have been associated with Mr. Irish for probably the last forty-two or three years, both at the Solar Refining Company and the last thirty-three years here at the Atlantic; he has been retired for a couple years, but I am still acquainted with him. He worked for the Solar Refining Company.

Q. I would also like to ask if you knew a Mr. J. G. Neubauer? A. Yes, sir, very well. I knew him at Lima, Ohio, about the same time as I knew Mr.—oh, from 1891 on; Mr. Neubauer was the auditor out there at that time; he did the soliciting.

Q. Was this work which VanDyke and Frasch did in the acidizing of oil wells done for the Solar Refining Company, do you know? A. I don't know.

Q. Do you know whether Frasch or VanDyke themselves owned the wells upon which the process was performed? A. I don't know; I don't believe they did.

Q. Do you know whether they were ever paid for acidizing any wells for someone else? A. Not of my own personal knowledge, but I believe the process was a commercial one.

Q. Do you have any idea whether they discontinued that or why they discontinued it? A. No.

Q. On your cross examination you mentioned asphalt paint. Aside from any knowledge of what Frasch and VanDyke did, would you know from your experience at the refinery whether that would protect iron from acid? A. It would help.

Q. Do you know in whose possession the file from which all these exhibits were taken has been since Mr. VanDyke's death? A. Well, they were in Mr. VanDyke's personal files up until the time of his death, and then they went into the executors' hands—Mr. Colley and Mr. Tuttle.

WILLIAM M. IRISH,

called on behalf of defendant, testified as follows by deposition:

DIRECT EXAMINATION

By Mr. Babcock:

I reside at 1047 Rider's Creek Road, Wynnewood, Pennsylvania, and am a retired corporation executive. Before I retired I was president of the Atlantic Refining

Company from 1927 to 1937. My entire business experience was in the oil industry. Leaving college in 1890, I was employed for a few months with the Acme Oil Company at Olean, New York. Then I went to Lima, Ohio, in the employ of the Solar Refining Company in May of 1891. At that time Mr. J. W. VanDyke was general manager of the Solar Refining Company and I began work under him and continued at Lima with the same corporation until February of 1903 when Mr. VanDyke came to Philadelphia as general manager of the Philadelphia plant of the Atlantic Refining Company. I came with him at that time and continued in the employ of the Atlantic Refining Company under several designations until, as previously stated, I became president in 1927, at which time Mr. VanDyke became chairman of the board.

I knew Mr. Herman Frasch from meeting him first in the summer of 1890 and subsequently many times when he was in Lima for business purposes. I saw him one or more times after I left Lima; I do not recall the particular dates. He was a chemist who invented a process for desulphurizing petroleum products and at the time I have mentioned he was in the employ of the Standard Oil Company for the development of that process and allied problems.

Mr. VanDyke was not a chemist. By training he was an engineer, but absorbed a great deal of chemical information in consequence of his work particularly in the desulphurizing of petroleum products, which was the operation that made the Northwestern Ohio crude petroleum commercially valuable. To the best of my knowledge, Mr. Frasch was a graduate of a German university.

Q. I understand he was called to Lima to work on the particular problem in the refining dealing with the desulphurizing of oil. Is that correct? A. Yes. I don't know how much informal talking you want me to do, but as of the dates we have in mind, the valuable product of petroleum anywhere was illuminating oil. The Ohio wells, the Northwestern Ohio wells—the discovery being made in Lima, Ohio—carried sulphur compounds which when pres-

ent in illuminating oils made those oils non-commercial, producing clouding of chimneys, coating of wicks and odors and so forth, so that the Frasch discovery was a means of desulphurizing the distillates that were used for illumination oils. That was what made the Lima, Ohio, oils commercially valuable.

Q. Did you ever have any knowledge of whether or not Frasch or VanDyke or either of them ever did anything in connection with the production of oil at or near Lima, Ohio, particularly relative to the idea of treating in earth formation with acid or anything of the sort, with the intention to improve the well? A. Yes, I know that in the early 1890's Mr. VanDyke and Mr. Frasch conceived the idea that the porosity of the oil bearing rock in the Ohio area could be increased by subjecting the rock, which was a limestone, to the action of acid. I know that they took out a patent in that connection and that they practiced the art to quite an appreciable extent during the period of a few years.

Q. Do you know what kind of acid they intended to use? A. Hydrochloric acid.

Q. Did either of them ever suggest any other acid, do you know? A. I particularly know VanDyke was anxious to use sulphuric acid. Parenthetically, you probably know that a great deal of sulphuric acid is used in oil refining. It is an acid with which he was very familiar and it was difficult for him to be persuaded that calcium sulphate that was formed was not soluble, and therefore wouldn't make much burrowing in the limestone.

Q. What was Frasch's particular idea with regard to that, if you know? A. Well, Mr. Frasch was a chemist, and he knew, of course, that hydrochloric acid was the natural and best solvent for the purpose intended.

Q. Have you any way in which you can fix a date, that is, just generally state whether it was in the 1890's or 1900 that this work took place? A. From memory, the work was in 1895, 6, 7. It was during Mr. VanDyke's residence in Lima, and while I was associated with him in the employ of the Solar Refining Company.

Q. Do you know whether or not Mr. Frasch or Mr. VanDyke owned themselves or either of them owned the oil wells upon which this treatment was used, or were they owned by someone else? A. To the best of my knowledge neither Mr. VanDyke nor Mr. Frasch were owners of the oil wells in their operations. The acidizing operations were carried on on the wells of producers other than themselves.

Q. Did the Solar Refining Company own those wells? A. No, the Solar owned no wells. To the best of my knowledge and belief, they had nothing to do with these treatments. Mr. VanDyke worked for the Solar Refining Company at that time, or was manager, but this work was something he did for himself, entirely for himself.

Q. Do you know whether he was ever paid or remunerated in any way for this work? A. I am entirely confident that much of the work was on a commercial basis; namely, he was paid for the operation. Of course, I had no personal contact with it, or, I know nothing about the accounting. I am quite confident the acid which was used in these treatments was from the Grasselli Chemical Company of Cleveland. They were the supplier of the Solar Refining Company's sulphuric acid. I have no knowledge as to how much acid was bought for this purpose.

I never saw the operation carried on of acidizing a well. My knowledge of what was being done and what was being thought about was from listening in and, to an extent participating in discussions in the laboratory and statements made to me by Mr. VanDyke on what the work was that they had done in the field. I knew a Morris G. Harper there at that time. He was the pipefitter foreman for the Solar Refining Company. I knew him very well, indeed.

Q. Did you ever discuss this work of acidizing oil wells with him? A. No, probably in the sense your question is asked, I never discussed it with him. I knew he was carrying on the operations. I saw the equipment that was used—got together and used for the purpose as it was prepared for hauling into the field. Principally small pipes or tubing that was used for carrying the acid on to the

horizon level, with some hand pumps having pressure on them to force the acid down the pipes.

Q. Do you have any personal recollection as to what measures were taken, if any, to protect those small pipes or tubing from the acid—from the corrosive effect of the acid? A. From observation, I knew that the pipe that was used was coated with a lacquer or asphaltous acid resisting coating. Its appearance was dark brown to black.

Q. Would you call it a paint or enamel, or something of that sort? A. I referred to it as a lacquer; not technically; it was a coating of paint as—

Q. Where did you see this material, the pumps and tubing? A. On the property of the Solar Refining Company at Lima where they were assembled; the things were assembled for trucking to the field.

Q. Did you ever discuss with anyone the reason why this paint was put on the pipes? A. I have no recollection of discussing it. The purpose was so obvious. The purpose was to protect the steel pipes from the attack of the hydrochloric acid.

Q. Was it known at that time that hydrochloric acid would attack steel pipes if they were not protected? A. I should say that was almost common knowledge.

Q. Was it known at that time whether hydrochloric acid would react with limestone? A. Oh, yes.

Q. Do you have any recollection as to who owned the wells or who this work was done for? That is, could you give us the names of any parties who might have owned wells? A. The one name that comes back to me quite definitely is that of VanCleave, who was an oil producer, but I was about to say I don't know whether they operated leases in his own name or under a company name, and if it was a company name I don't know what it was.

Q. Do you have any knowledge as to whether or not this work, this acidizing of wells was successful, That is, whether it increased the production or whether it ruined the wells, or anything of that sort? A. I know by a report it was considered very successful. They had repeated op-

erations from persons—from producers who employed the process, and I was told by Mr. VanDyke that the records were that the costs of operations were returned to the producers in a number of cases in a very few months through increased rate of production.

Q. Do you have any knowledge as to whether either Mr. VanDyke or Mr. Frasch continued this work after say about 1898? A. I am certain that Mr. VanDyke did not carry on appreciably beyond that date or, at least, not after he moved to Philadelphia.

Q. Do you have any knowledge as to why Mr. VanDyke discontinued this work? A. It would only be a surmise, that other activities with which he had engaged and with which I was casually familiar, were taking his time.

Mr. Conner: Objected to as conjectural, not being based on the witness' own knowledge.

Q. (By Mr. Babcock): You may go ahead and answer, please, Mr. Irish. A. All I was going to add was he found other activities more attractive.

Q. Would you please state what some of the other activities of Mr. VanDyke were at or about that time, if you know? A. At about that time he purchased an interest in a paper mill in Middletown, Ohio, and subsequently acquired the entire interest. I might add that he gave considerable time to the organization and management of that business which he carried on for ten or a dozen years.

Q. Did Mr. VanDyke engage in other activities in addition to that which you have mentioned in the period say from 1898 on for the next eight or ten years? A. Yes, he had investments in a number of directions, to which he gave time and attention.

Q. How wealthy a man was he at that time, if you know? A. I would not feel competent to appraise his wealth at that time.

Q. Well, I didn't mean numerically, exactly, I meant would you consider that he was fairly well to do at that time and had money invested in various activities? A. Yes.

Q. Do you have any knowledge as to whether Mr.

Frasch became interested in other activities during the period say from 1895 to 1905, or along in there? A. I know from hearing Mr. Frasch describe it, that during the period you name he was developing and carrying on the mining of sulphur in Louisiana with the injection of very hot water into the sulphur—underground sulphur deposits and bringing the sulphur up in a molten condition.

Q. Mr. Irish, I believe you have mentioned you knew Mr. Morris G. Harper, at Lima, Ohio? A. Yes. I also knew C. F. Lufkin. He was a resident of Lima and an oil producer, and I think also was affiliated with the Ohio Oil Company during the period about which I have testified, around 1895. I know Howard Nichols very well. Knew him at Lima, Ohio, at about that time. He is the same Howard Nichols that I saw here this morning. I do not recall an A. W. Harmon. I knew Frank Harmon. He was a merchant.

I knew a patent attorney by the name of Charles J. Hedrick. I knew him personally. He took out a patent in about 1906 in the name of VanDyke and Irish; a distillation patent.

I knew J. C. Donnell of the Ohio Oil Company very well. I did not know him during the period about which I have testified, that is from 1890 on up to 1903 or so. I knew of him, but never met him until a subsequent time. I would say ten years later, when he was president of the Ohio Company.

I knew Mr. J. G. Neubauer very well. He was auditor for the Soiar Refining Company during all of the years that I was connected with that company and resident in Lima. I have recently been told that he is living somewhere on Long Island. I have forgotten the name of the place.

Mr. Babcock: I have here some papers about which Mr. Nichols testified this morning, and would like the witness to state whether he has ever seen these letters or that file before today. A. I never have seen the DX-72. Probably the same answer will apply to the other. The signature on DX-72 is Mr. G. Harper, and to the best of my rec-

ollection it is his handwriting. I saw his handwriting frequently in 1895 and during that period. The signature was on store room orders and other routine documents.

Q. I will ask the witness to go through the papers which he has before him and which papers have been marked for purposes of identification during the testimony of Mr. Nichols this morning, and point out any other signatures which he recognizes as those of the person which they purport to be signed by. A. I would say that this telegram, Harmon is the original signature. DX-82 was written by Mr. VanDyke's secretary, Miss Burge. DX-87 has Mr. Charles J. Hedrick's signature. DX-89 are the same, Mr. Hedrick's signature. I can not identify the writing in DX-90. It is obviously from Herman Frasch. DX-91 is Mr. Hedrick's. DX-101 has M. G. Harper's signature.

Q. With reference to DX-101, I would like to ask the witness if he can identify any of the initials or writing in pencil on that sheet of paper? A. This pencil memorandum apparently is in Mr. VanDyke's handwriting. It also has the name Mr. McCarthy, whom I knew. He was superintendent for the Solar Refining Company while the titles and activities were not specifically defined on any organization chart, to the best of my knowledge and belief Mr. McCarthy was a mechanical superintendent of the Solar Refining Company while I was supervising the process work. I recognize his signature on the back of the sheet of paper marked DX-101. He has been dead a number of years. DX-102 are Mr. Harper's. DX-105 is Miss Burge's writing. DX-106 is Mr. Harper's. DX-108 are Harper's. DX-109 is Mr. VanDyke's. DX-111 are Mr. Harper's, and DX-113 is Mr. VanDyke's.

Q. During the period from 1895 or within five years either way, were you familiar with the writing and signatures of John W. VanDyke, Morris Harper, and the others whom you have testified here today as being the signatures of those men? A. Yes, with the exception of the signature of Mr. Hedrick, the writing and signature of Mr. Hedrick with which I became familiar about 1906 instead of at the earlier date

CROSS EXAMINATION

By Mr. Conner:

I first knew Mr. John W. VanDyke in February of 1891; that's when I first met him. That was in Lima. I was subsequently associated with Mr. VanDyke in business continuously from May, 1891, until May, 1937, and was familiar with his connection with the petroleum business. He was chairman of the board of the Atlantic Refining Company from 1927 to the time of his death in September, 1939. He was president of the Atlantic Oil Producing Company and was associated with the Atlantic Oil Shipping Company, the Keystone Pipe Line Company, the Venezuelan Atlantic Refining Company and the Buffalo Pipe Line Company. Those are all subsidiary companies of the Atlantic Refining Company and Mr. VanDyke was president of these several companies. He also was a member of the American Petroleum Institute.

Q. What, if any, was Mr. VanDyke's connection with the Standard Oil Company and during what period of time? A. He entered the employ of the Standard Oil Company at Long Island City in the—from hearsay this is—in the early 70's and continued in the employment, located part of the time at Long Island City and part of the time at King's County Oil Works in Brooklyn, until 1886 when he went to Lima in the employ of the Solar Refining Company which was a Standard Oil Company subsidiary.

Q. Then from your own knowledge from the time of 1891 until the time of Mr. VanDyke's retirement, you know of your own knowledge that Mr. VanDyke was actively engaged in the petroleum business? A. Yes.

Q. Dealing with all the various phases of petroleum? A. Yes.

Q. What if any association did Mr. VanDyke have dealing with the production of oil from the earth and the drilling of wells, producing wells and increasing their production? A. From 1891 until 1916 he had no active con-

nection except this acidizing operation which has been under consideration. In 1916 the Atlantic Refining Company organized the Atlantic Oil Producing Company, of which Mr. VanDyke was an officer.

Q. Was the Atlantic Oil Producing Company concerned with the production of oil? A. Yes. It was an Atlantic Refining Company subsidiary organized, as I recall it, in 1916 for that specific purpose.

The first time I met Mr. Herman Frasch was in July of 1890 in Paris, France. Our association thereafter was quite close up to the late 90's. When I was in Lima he was there frequently on business relative to the refining of petroleum, desulphurizing particularly.

From 1891 to 1903 I was the superintendent of the Solar Refining Company supervising their process operations. We were engaged in the refinement of petroleum. I had no occasion to do any work directed towards the production of oil such as drilling wells and the like. The only occasion I have had to do any such work has been in a supervisory capacity since the organization of the Atlantic Oil Producing Company, of which I was an officer. It was organized in 1916, if my memory holds.

Q. You stated on direct examination—I am paraphrasing you, not quoting you—that Mr. Frasch and Mr. Van Dyke applied hydrochloric acid, or acid to a well. Were you present when that was done? A. No. I never saw the operation on a well.

Q. Then how did you acquire your knowledge that such was done? A. By statements of Mr. VanDyke and others.

Q. Do you have any personal records or any records that came to you as an official of the company which would tend to show such an operation of acidizing or treatment of wells with acid at or during that period you testified to from 1895 to 1897? A. No records.

Q. How did you acquire your knowledge as to the structure of these pipes you testified to, I think—again paraphrasing you and not quoting you—which pipes were

coated with asphalt or rubber? A. By seeing the pipes assembled with equipment that was going out to the field for that purpose. I saw those pipes and observed their structure.

Q. Do you know to what purpose they were put and how they were used? A. I know that they were—the purpose that they were stated to be used for.

Q. You did not see them employed in the treating of wells, did you? A. No, I did not see them employed.

Q. I think you also testified on direct examination that such wells as Mr. Frasch and/or Mr. VanDyke may have treated with hydrochloric acid during the period 1895 to 1897—I think you stated that the treatment of those wells was paid for. Will you please tell me how you know that, if you do? A. I trust I stated I was told by Mr. VanDyke that those results were achieved. Of my own knowledge I don't know whether they were paid for or not.

Q. Not having been present when these wells were treated in this period, you don't know whether acid, or hydrochloric acid or what was used in them, is that correct? A. That is correct.

Q. Subsequent to the period of 1895 to 1897 when Frasch and VanDyke were reputed to have treated these wells, what do you know of any operations of a similar nature that were done by these parties or any other parties in connection with treating wells with acid or hydrochloric acid? A. I know of nothing by these parties. Other parties, I know that, have in the past. For many years acidizing has been an operation in the oil fields.

Q. To your knowledge when did that work start? This is subsequent operation you speak of, do you know whether it was prior to, for instance, 1933 or 4, or was it subsequent to 1934? A. I have no way of fixing the date.

Q. I will ask you this, do you know or have you any knowledge of any acidizing or treatment of wells with acid which was done between the years of 1895 and 1932 which was done other than that done by—reputed to have been done by Frasch and VanDyke? A. No. I would have

thought merely from memory that there were operations along about 1929 but I haven't any way of fixing any.

Q. I believe you testified on direct examination that these treatments of wells by Frasch and VanDyke in 1895 and in 1897 were successful. If that is the way you testified, how do you know that they were successful? A. From the same source, statements by Mr. VanDyke and others that I have already said.

Q. Did you ever contact the operators of those wells to ascertain to what degree, if any, success was present? A. No; I have had Mr. VanCleave tell me that it was successful.

Q. This file that was presented to you here this afternoon and which you examined, when did you first see that, Mr. Irish? A. After it was presented here.

REDIRECT EXAMINATION

By Mr. Babcock:

Q. I didn't quite understand just what your testimony was with reference to the Atlantic Oil Producing Company. A. That was organized about 1916 and I was an officer.

Q. Did you know in 1916 that limestone formations in oil wells could be acidized? A. Yes.

Q. Of your own knowledge, did you know that if you had wanted to acidize the limestone formation of a well you could do so? A. I will answer yes.

Q. When did you first gain knowledge, would you say, that that could be done? A. Through the work that was done by VanDyke and Frasch.

Q. Would you say that in 1916 and also in 1897 you knew of a method of increasing the output of a well for producing a fluid mineral product such as oil, gas, water or brine in which the essential steps consisted in introducing into the well an aqueous hydrochloric acid solution with some method of inhibiting action of acid upon metals? A. The question is whether I knew of such a method?

Q. Yes. A. The answer is yes, with the reservation

as to the question about inhibiting the acid; I am not clear whether the protection of metal comes under the head of inhibitor or not.

Q. Assuming in the question instead of using the word inhibit I had used the word protect the pipes from the action of the acid, or protect metals from the action of acid, what would your answer be? A. It would be yes.

Q. Did you also have knowledge in 1916 or in 1897 that such a method could be used in increasing the production of oil found in a limestone formation bearing oil, by the use of hydrochloric acid? A. The answer would be yes.

RECROSS EXAMINATION

By Mr. Conner:

Q. Are you familiar, Mr. Irish, with any method of inhibiting the action of acid such as hydrochloric acid on metals? A. Under my conception of the definition of inhibit, I am not familiar with it.

Q. What is your conception of inhibiting? A. Well, it is a neutralizing of action, if I can express it that way, or an action, rather; a protection against it.

Q. Are you a chemist, Mr. Irish? A. I took a degree in chemistry but I never became a chemist.

Q. Are you familiar, Mr. Irish, with the use of inhibitors in connection with acidizing wells as those inhibitors are used today and have been used since 1934? A. No.

ROBERT H. COLLEY,

a witness called on behalf of defendant, testified as follows by deposition:

DIRECT EXAMINATION

By Mr. Saye:

I am president of the Atlantic Refining Company and was acquainted with Mr. John W. VanDyke for twenty years during his lifetime. I am one of two executors of his estate. He died September 13, 1939.

As one of the executors of the estate of John W. VanDyke, deceased, I took possession of his files, records, books, and papers immediately after his death.

Q. Mr. Colley, I hand you a file which contains various written instruments, a great many of which have been marked for identification with letters and figures in this proceeding and regarding which Mr. Howard Nichols has testified. For your information, they have also been testified about by Mr. William M. Irish. I will ask you please to inspect or examine this file which I now hand you and state whether or not those papers and instruments came into your possession as one of the executors of the estate of John W. VanDyke, deceased, and whether or not they were found in his files and are a part of his personal papers and records? A. After examining the file, I recognize them to be Mr. VanDyke's papers which we found in a large wooden chest in an inside room adjacent to his personal office where other of his personal papers were filed. This file has been in my possession as executor since it was found and is now at this time.

CROSS EXAMINATION

By Mr. Conner:

I found these papers in a large wooden chest that stood in an inside room adjacent to his own personal private office. Prior to Mr. VanDyke's death they were in his possession; they were in his office, in the anteroom.

BESSIE G. McKAIN,

a witness called on behalf of defendant, testified as follows by deposition:

DIRECT EXAMINATION

By Mr. Saye:

I was acquainted with Mr. John W. VanDyke during his lifetime. I was in his employ as secretary from, I think it was December, 1925, until his death, September 13, 1939.

Q. I will ask you to examine a file which I hand you which contains various instruments and documents, and for your information I will state some of them have been identified by certain letters and figures this morning and have been testified about by certain witnesses, and I ask you to state if you ever saw that file before? A. (The witness examined a file.) Yes, I have. To the best of my knowledge, I first saw this file over two years ago. It was then in an old chest personally owned by Mr. VanDyke which he had brought from storage to the little anteroom outside of his office, which was part of his office. It was a little conference room. It was placed in there and Mr. VanDyke and I went through the chest at the time as he wanted to see just what was in it. It had come from Lima; he had brought it from Lima many years before that and this package of papers—it was then in a package—was in the chest. These instruments which I have before me are the personal effects of John W. VanDyke, deceased. They remained in his possession from the time I first saw them until his death. They were in that chest. The chest was locked.

Q. Do you know where they have been since that date? A. Well, now, immediately after Mr. VanDyke passed away, we were cleaning out his effects in the office, going through all his papers. I mean Mr. Tuttle, one of the executors of the estate and I personally went through this old chest and we separated the different subject matters into

different piles, and this was one of them, this acid treatment of wells, and it was either given to Mr. Nichols, the plant superintendent, or to Dr. Delbridge. I am inclined to think it went down to Mr. Nichols and he gave it then to Dr. Delbridge, and Dr. Delbridge went through it, I believe, and then it came back to me to be kept for safe keeping until it was needed. I don't know whether it went to Dr. Delbridge first or Mr. Nichols; one or the other.

Q. At any rate then, as I understand your testimony, with the exception of the persons whom you have just named who may have had possession of the file at some time since Mr. VanDyke's death, the papers and file have been in your possession or in the possession of the executors, which? A. Mr. Tuttle is one of them.

Q. I believe you said it was returned to you. Do you act in some capacity for or with the executors? A. Yes, I am doing the work for the executors on Mr. VanDyke's estate. That is the clerical and stenographic work. Subsequent to Mr. VanDyke's death I have been in active touch with his affairs as secretary or assistant to the executors who are looking after his affairs. Mr. Robert H. Colley is one of the executors. Mr. Tuttle's full name is Robert C. Tuttle. He is not available, he is ill. He has had a slight operation. He is vice-president of the Atlantic Refining Company and a director and he resides here in Philadelphia.

CROSS EXAMINATION

By Mr. Conner:

Prior to Mr. VanDyke's death these papers were under my supervision in so far as keeping the key for this chest is concerned, the chest that contained the papers. When the chest was brought up, Mr. VanDyke and I hunted up the key and opened it up and looked through the papers, and then he gave me that key.

Q. Will you be willing to state that these papers have been under your supervision since about 1936 or 7 until the date of Mr. VanDyke's death? A. I think I would, yes.

That chest was in his office quite a long time, but there wasn't any reason for me to keep a definite date, and I didn't do it.

Q. What actual personal knowledge do you have as to the whereabouts of these papers prior to the time they came under your supervision, before 1936 or 7? A. Well, they were in that old locked chest down, I think it was down in our own basement, in one of the vaults.

Q. Did you see them there? A. No, I didn't. The chest was sent up to the office.

Q. How do you know it was in this basement? A. Well, as I recall it, it is a little hazy in my memory now, but as I recall it, the man who has charge of our supplies in the basement, where we have a place for storage of things, called me up and told me it was there, and Mr. VanDyke said to have it sent up to the office as he wanted to go through it to see just what he did have in it.

Q. Do you actually know who it was that had charge of the papers before they came into your office? A. If I am right that that is where the chest came from, I can give you the name of the man who called and told me that the chest was there. I never saw the papers until they came into the office. After they came into the office that chest was in my care. But prior to that I don't know whose care they were in.

JOHN J. NEUBAUER,

a witness produced on behalf of the defendant, testified as follows by deposition:

DIRECT EXAMINATION

By Mr. Babcock:

I live at Elmhurst, N. Y. I was associated with the Solar Refining Company at Lima, Ohio, from 1886 to 1923, when I retired. I was president of the company from 1911 to 1923. I ran all up the line. I was cashier, auditor, superintendent, assistant manager, then manager and then president.

I knew John W. VanDyke. He was a resident manager of the Solar Refining Company, and I was under his supervision. I first met him in Long Island City. That was back prior to 1879. I worked for the Standard Oil Company and went to Lima, Ohio, in 1886. That is when Mr. VanDyke went there.

I knew Herman Frasch. He was doing a little refining in Petrolia, Canada. I think that is the name, I am not sure, but he had a little refinery there. I met him at Lima. He came there to Lima probably along about 1888. It was a year or two after we went out there. The occasion of his coming there, he had a little refinery there, and, of course, the oil there at Lima was the same, about, as it was in Canada; it had a great deal of sulphur deposits in the oil, and, of course, all refineries at that time were built for illuminating oil commonly known as kerosene oil. Naphtha was a by-product at those times. We used to call gasoline naphtha, and it was a by-product, and refineries were all built for kerosene oils. The Lima oil had so much sulphur in it that we couldn't make any kerosene oil without—after you had lit the lamp a short time, the lamp would all cloud up with the sulphur fumes. We had to eliminate that sulphur to make it merchantable oil, and Mr. Frasch claimed

that he had a process that would eliminate the sulphur, and he made this for the Standard Oil Company, I suppose, and they sent him there to demonstrate that he could do that, and he experimented, and at first we didn't get along very well with the experiments, but, anyway, they had a plant in Cleveland, called the Clark Plant, where they built a couple of stills and experimented, he and Mr. VanDyke together. It was on that occasion that I first met Mr. Frasch.

Q. Did you ever have any knowledge of any treatment of oil wells by Mr. Frasch or Mr. VanDyke? A. Yes. Mr. Frasch claimed or he said that he could use an acid method by forcing the acid down by pressure, and the Trenton rock—the oil there was in what we called the "Trenton rock"—and he claimed he could force that down and eat out the rock. It is a porous rock; the oil rocks are porous, something like a sponge, I suppose, and those get clogged up at times, and he forced this acid down to clean that out and open up this rock so the oil could flow back in again. They began experiments, and we had a man that was a pipefitter in Lima by the name of Morris Harper. He was employed by the Solar, and they sent him down and tried it on several wells with some success, but I heard that there was some of that rock that it didn't work on so well.

Q. Do you recall who told you that? A. That's what I heard, you know, but they experimented and run it for quite a while, but what became of it I don't know, whether they discontinued it or not.

Q. You said Morris Harper did the work, but whom did he do it for, do you know? A. Mr. Frasch and Mr. VanDyke.

Q. What was their relation to each other? A. Harper was employed by the Solar Refining Company under VanDyke.

Q. Were the wells acidized for the Solar Refining Company? A. That I couldn't tell you, whether done for the Solar Refining Company.

Q. Do you know whether Frasch or VanDyke or either of them were ever paid for any of this work by any-

one? A. Not that I know of. At that time I wasn't in a position to know very much. At that time I was simply a bookkeeper and cashier.

Q. Do you know what chemical was used? A. There's a question! I had an idea it was muriatic acid; whether it was hydrochloric I don't know. I don't know whether it was hydrochloric acid, but I think we got,—they got the acid from Grasselli Chemical. They furnished us sulphuric acid; they did all the acid business with the Solar. Whether it was muriatic acid or some other acid I don't know, but I have an idea it was muriatic acid. It was acid all right.

Q. Mr. Neubauer, I have here a certified copy of the File Wrapper and Contents of an application for Letters Patent filed in the Patent Office on June 27, 1895, this being filed in the name of John W. VanDyke, Serial No. 554,182, and which matured into U. S. Patent No. 556,651 on March 17, 1896. In this file I find an oath which purports to be signed by John W. VanDyke and sworn and subscribed to before J. J. Neubauer, notary public. I will ask you to refer to this photostat which I have here and see if you recognize any of the signatures there (handing to the witness)? A. Yes, that is VanDyke's signature, and that is my signature. I was a notary public there at that time.

CROSS EXAMINATION

By Mr. Conner:

Q. Mr. Neubauer, what other business or work have you ever done, other than in connection with the Solar Refining Company, which took you into the field of petroleum? A. I don't think I did anything else,—because I have a sixty-year pin here (referring to a pin in the lapel of his coat).

Q. How old were you when you first went to work with the Solar Refining Company at Lima, Ohio? A. Well, I was born in 1853, and I went to the Solar Refining Company in 1879.

Q. Then you were with the Solar Refining Company

practically all your life? A. Yes. Before that I did a little—I didn't have any special jobs, but practically it has been my whole life in the oil business.

Q. Have you ever done any work in the field producing oil from the ground? A. No; strictly refiner. No production work at all. No drilling of wells.

Q. Do you purport to know anything about production practices and drilling practices? A. No, but the producers were all friends of mine and I heard the talk, but practically I had no personal knowledge of producing.

Q. I wish you would tell me, Mr. Neubauer, just what it was Mr. Frasch and Mr. VanDyke were supposed to have done out there near Lima, Ohio, between the years 1895, we will say, and 1900 in connection with putting acid in wells? Just what is your understanding of what they did? A. They forced the acid down and put a pressure on it. And, of course, left it down there, I suppose—it is my idea only—forced this acid down under pressure and kept it under pressure for a certain time and then released it.

Q. Have you any idea how many wells they worked on? A. No; they did quite a few around 1895. I was never present when any of this work was done.

Q. How do you know that they are supposed to have used acid in this work? A. I know that was furnished through the Solar Refining Company; the Solar furnished acid from the Grasselli Chemical Company, and the talk was acid, and I have an idea of muriatic acid, but I am not sure of that, but it was acid that they put down there.

Q. You were never present to see that work done, however, were you? A. No.

L. C. CASE,

a witness for defendant, testified in Dow vs. Williams as follows:

DIRECT EXAMINATION

I live in Tulsa, Oklahoma, and am employed as a chemist by Gypsy Oil Company. I have been employed by them slightly more than nine years.

I knew of an operation consisting of the treatment of an oil well by the Gypsy Oil Company with hydrochloric acid in 1928. I had nothing to do with such treatment, except I scanned the report from our Pittsburgh laboratory making the recommendations.

I had something to do with treating of oil wells at a subsequent time, in July, 1931. We introduced daily charges of dilute hydrochloric acid and an inhibitor down the casing of the well for the purpose of removing scale from the rods and tubing of the well, and for the purpose of removing any scale from the face of the sand or crevices in the sand at the bottom of the well. The scale we had in mind of removing was calcium carbonate scale. The well was located in the Glenn Pool. I couldn't say what county. I remember these things by location. I believe it is Creek County, either that or Tulsa County.

The process that was followed was the simple dilution of commercial hydrochloric acid with water and adding the inhibitor, and then introducing that solution into a dram at the well head, and that was in turn let out of the drum through a hose some distance down into the casing to prevent the vacuum on the well head from drawing that solution back up out of the pipe, and it was allowed to trickle down the casing. It was calculated that a sufficient charge was put in each day to allow that to go to the bottom of the hole and there come in contact with the scale on the rods and tubing and sand face of the formation. The so-called

inhibitor that we placed in this diluted solution of hydrochloric acid was rodine. That was the inhibitor that had been recommended by our research department in 1928.

Q. Did you ever know of rodine being used in the oil fraternity for any purpose whatsoever prior to the time it was recommended for the cleaning out of this well? A. It had been used in cleaning out of engine jackets that had scaled up with what is commonly known as gyp; it is really calcium carbonate scale due to impure water being used in the boiler, and also working barrels and pump equipment, by immersing the acid inhibitor with rodine.

In common language calcium carbonate is limestone. I have no remembrance of the actual amount of hydrochloric acid we put in this well. It was several gallons. A few gallons, one or more gallons I believe it was, five or more gallons a day of the diluted acid was introduced into the well. It was necessary to introduce more than one gallon because the introduction of only one gallon would not allow it to reach the bottom of the hole; it would dry out on the surface of the casing in going down. Now that doesn't mean we put in more than a gallon of the commercial acid, but a certain amount of acid was taken, for instance a quart of the commercial hydrochloric acid and dilute it with five or six gallons, and that in turn was introduced into the well daily. The inhibitor was poured first into the commercial hydrochloric acid and stirred and then diluted with water in a drum. I noticed whether or not this inhibited hydrochloric acid corroded the drum into which it was placed. I didn't notice any corrosion.

I had no occasion to examine the well that was treated in 1931 at a subsequent time to see whether or not the gyp or calcium carbonate was removed and there was any corrosive effect of the hydrochloric acid upon the equipment, casing and tubing, sustained by reason of that treatment. I ascertained whether or not the calcium carbonate was dissolved or removed only by inference. The well seemed to improve somewhat in its action in regard to pulling jobs made necessary by scaling up of the permanent equipment.

As to production I am not sure, I had nothing to do with any other wells other than the one in July, 1931. I suppose that the well which was treated with this hydrochloric acid into which an inhibitor had been introduced in July, 1931, would be considered of rather shallow depth for this country, about sixteen or seventeen hundred feet. Probably between fifteen and sixteen hundred feet deep.

CROSS EXAMINATION

I was in charge of the chemical laboratory for the Gypsy Oil Company when I went with them some nine years ago, and have been in charge of what laboratory there is since that time.

I have always cooperated with our field engineers. The field problems coming under my supervision, as head of the chemical department, were water treatment for scale prevention; scale removal from all field equipment, including wells and boilers; corrosion of pipe lines, pumping equipment; water shutoff problems in oil wells; miscellaneous odds and ends of inorganic matters. The field division maintained a laboratory aside from mine. I believe that would correctly be called in charge of our chief engineer at the time. This laboratory, as I remember it, didn't have a man in it at all times but was a laboratory that was used intermittently by our engineers and under the direction of the chief engineer. The chief engineer at that time was Mr. H. H. Power. Perhaps he would not plead guilty to being a chemist, but I believe he is a pretty good chemist. I think he had training and experience in chemistry.

I knew of the use of hydrochloric acid in an oil well in 1928. I learned that from two men in the engineering department, R. L. Wright in particular. Mr. R. L. Wright was chief engineer at that time in 1928. He is not with the company now. He mentioned to me that that work was to be done; discussed the report from Pittsburgh making the recommendation. Then I later saw the report in the office of our production department. I did not see the acid used

in this well in 1928. It was on the William Berryhill lease. I believe it was number 8, but I am not absolutely certain. The acid put into the well was hydrochloric acid with the inhibitor, rodine. Five or six gallons of solution from one gallon of acid was put in the well I had charge of myself in 1931. I am fairly certain 177 gallons of commercial hydrochloric acid was put in the first well in 1928.

I believe that the report from Pittsburgh regarding this use of acid was made by Dr. Foote personally to Mr. Henry McGraw, then our vice-president, and it would naturally be in his files, or his successor's files. The report or recommendation coming from Pittsburgh had its origin in Pittsburgh this way—well perhaps I would be presuming in saying how it had its origin. Those men made the research on the action of hydrochloric acid on steel, tested a piece in the presence of the rodine inhibitor, and included therewith the recommendation for the well treatment. Now, what led to their original idea was possibly, probably, even some practice they had noticed out here before they started their investigation. I know of no practice they observed out here before they made this investigation and recommendation. The treatment in 1928 was followed out according to the recommendations made in the report from Pittsburgh. I know of no communication between the office of the Gypsy Company here in Oklahoma and the Pittsburgh offices prior to the written recommendation that came back from Pittsburgh.

I didn't observe this well under treatment in 1928. I didn't visit the site of the well, therefore I couldn't see any drums of inhibitor. I was not at the well site while this treatment was being made in 1928. I didn't see that done at all. I got my information about it from talking to the chief engineer and reading this report. I was present in the treating of the well in 1931. The name of the well I treated in 1931 was the Jacob Anderson.

R. L. WRIGHT,

a witness for defendant, testified in Dow vs. Williams, as follows:

DIRECT EXAMINATION

I live at Wichita, Kansas, and am a petroleum engineer. I was employed by the Gypsy Oil Company from 1924 to approximately 1930. I left the employ of the Gypsy Oil Company in July, 1930, I believe.

While in the employ of the Gypsy Oil Company I was stationed principally at Tulsa. My duties were to help carry on the engineering work which had to be done with the operation and producing of the properties and help develop any new methods or improvements in the operation.

I have a degree of mining engineering from Iowa State College, at Ames, Iowa. I took just an average amount of chemistry for an engineering curriculum. That extends a slight amount into a branch of chemistry beyond what we would call elementary chemistry.

While in the employ of the Gypsy Oil Company I was present at a time when some substance was put into an oil well for the purpose of facilitating the flow of oil. That was in the fall of 1928 or 1929, I just don't recall, that has been some time ago and I could not. I sent a report in connection with that. That well was treated with an inhibited hydrochloric acid, with the ultimate purpose in view of reducing well trouble and perhaps increasing the recovery from the well. I was there and personally had something to do with the measuring out of the rodine which was the inhibitor and adding it to the acid and helped pour the acid into the well. We had hydrochloric acid out at that well site. The rodine was originally ordered from the American Chemical Paint Company. I just happen to remember that name—or the name of the inhibitor because it is such an unusual name, and it had such a terrible odor to it, that

it identified itself as the substance. The rodine was ordered and received in Tulsa and subsequently it was transferred down to the Glenn Pool district and from the warehouse in the Glenn Pool district it was transferred to the well and it was measured out because the acid was received in carboys. We had been instructed and informed as to what the optimum percentage of inhibitor to use would be, and so in order to mix up this proper mixture and because our acid was distributed around in carboys, it was necessary to measure out a certain amount and put it into each carboy. I have charge of this addition of this so-called rodine into these carboys of acid. I was informed as to what to do and while I didn't consider myself specifically in charge of that work, why I helped outline and actually did the work. I don't remember the exact percentage of the total volume of the dilute hydrochloric acid or the rodine we put in, but I do recall that it was quite a small amount, say, oh, probably a quart to ten gallons. At any rate, just a few per cent. The rodine was just measured out into a measuring container which held the approximate amount and then was poured into the acid and the bottles were then agitated so that the rodine was perhaps stirred with a stick I don't recall. Then this mixture was poured into the well or rather lubricated in, so it was put in both the casing and the tubing, as I recall. The purpose of this, there was a considerable trouble from scales in wells in that area, all more or less small wells, and the liner barrel was used. Now the advantages of that was it can be run on the rod, which can be handled in a much quicker time and with less trouble. Now with these liner barrels inserted in the common barrel, when the scale would form it would tend to hang up these liner barrels in just the ordinary common working barrel so that it would be necessary to occasionally go in there and pull the rods, even though the wells did not need pulling, and just unseat this barrel, so when the time came to service that well it would only be necessary to pull the rods rather than have to pull what would be termed a wet stream, which would mean pulling the tubing and rods;

pretty much is a large time saving proposition, and the purpose of this was to partially eliminate this operating trouble of the gyp tending to stick the working parts in the bottom of the well.

This mixture of acid with the inhibitor was not immediately circulated in the well. The well was allowed to stand for some time. I don't recall exactly, it was either perhaps twenty-four or forty-eight hours, and at the end of that time, of course we didn't want to pump hydrochloric acid over into our tanks because of the bad effect on the tankage, so that as I recall the well was circulated until the acid was destroyed by its reaction with the scale, and I recall distinctly that a sample of that oil was taken and the well didn't make much water, but we took a sample of the oil and washed it with water, the idea being that any acid that would be with the oil, while it would not go into solution with the oil would go into solution with some more or less pure water and the presence of hydrochloric acid could be identified by an indicator such as litmus paper.

Of course we were trying to get pipeline oil, but we did not want pipeline oil. The ordinary test for pipeline oil does not include an analysis as to whether or not there was any acid in the oil, and we were testing specifically for an acid, and the important reason why we didn't want acid in the tanks in the oil was because of the effect on the tankage. We worked this acid, circulating it. Now, I wasn't there while that was being done but due to the nature of my work I knew it was done, and I was there when this sample of oil was secured and tested with litmus paper for acid content.

The reason I knew this was rodine, or a substance that was known as rodine, I had no other information other than it was rodine. I don't recall whether there was rodine stamped on the barrel in which it was received or not, but because of the shipping instructions on it and being notified from the warehouse that this drum had come in from the American Chemical Paint Company, why I just naturally assumed it was rodine, because at that time I was familiar

with the correspondence that had occurred between the Tulsa office and the Pittsburgh office regarding rodine and the general plan for the test, and I recall distinctly that I had in my desk at the office four little rings of tubing which were the result of tests made by the research department as to the inhibiting effect of these different percentages of rodine, and I believe there were, I don't know just how many, but I believe there was more than one rodine that was tested.

My signature appears on Plaintiff's Exhibit 152. That is the report which I prepared and signed in connection with this application and putting in of the hydrochloric acid inhibited into that well. I was present while this acid was being introduced.

Prior to that time I did not know anything about an agent called inhibitor. I did not have specific knowledge of them other than just a general information which you might have of reading of metals in school work. The reason we did not wish any of this acid to get into the flow tank, was that we just figured that it would not be a good thing to have in the flow tank, or that is in the stock tanks for the reason that occasionally you get more or less acids or you get oil on you and I had been present on several other occasions where chemicals had been used in the wells and I learned by experience that it was —any time that you were working around a chemical why you should know what to do in case you got any on you, and I knew that hydrochloric acid in oils would be a poor thing and when that oil hit the refinery, even though it was inhibited why it would be a poor thing. We were fearful that the inhibited hydrochloric acid would injure our tanks to a slight extent. We just were not perhaps completely sold on the idea that—we had always been more or less of an impression that when hydrochloric acid and metal got together they would more or less react.

CROSS EXAMINATION

My studies in chemistry included a high school course, a general college course and quantitative and qualitative analysis, not organic—inorganic chemistry. I have known about arsenic just in recent publications that have been in the trade journals describing the use of arsenic as an inhibitor in the present more or less intensive program of acidizing wells, which articles have occurred in the trade journals and discussing among various oil men what hydrochloric acid or rather acid treating is doing towards well potentials. That discussion started and these publications started to appear principally in the last year.

I have been located, or for the last year I have been located up in Wichita and in the State of Kansas. There is considerable lime production and there has been quite a lot of acidizing done up there, and it has just been in the time that I have been in Kansas I would say, or within the last year that I have had numerous conversations regarding acidizing. It was within the last year or about that time that these articles first started to appear in these publications reaching the oil fraternity, the trade journals, Oil and Gas Journal, Petroleum Engineer, and magazines of that nature. There is quite a little acid being used up in Kansas.

I don't know the exact number of producing companies employing that method on their wells, but I would say that most of the companies that have lime production have either acidized or hired somebody to acidize for them. That is with inhibited acid. To the best of my knowledge that is what they used. The procedure is such that anybody was going to acidize a well now I believe they would be more or less foolish not to acidize with inhibited acid. That is my opinion, a general opinion in acidizing oil wells. It is to protect the tubing and casing and metal parts of the well.

I could name some of the major companies that are employing the inhibited acid treatment in their wells, I believe the Gypsy; now I am not positive of that; the Gypsy, and Phillips, Mid-Kansas, and Texas Company; in fact most of

the major companies operating in Kansas are using that treatment and have been for the past year.

Before that time I had heard of arsenic without reference to its use as an inhibitor. I studied about arsenic in my high school work. I recognized it as one of the elements and its qualities and characteristics. I would say that I have known about hydrochloric acid, its characteristic qualities, in high school chemistry, which was along about 1915. I would say that I was familiar with the fact that hydrochloric acid solution, that is dilute acid, would react with limestone to form a carbon dioxide gas and calcium chloride for the past eleven or twelve years. I would say that I have known that arsenic is an inhibitor of hydrochloric acid within the last year. I never heard of that before. The reason is that there was a period of time that I was not in the oil producing country and was sort of out of touch with it and it has just been a matter of a little over a year ago that I came back down into this country and more or less familiarized myself with what was going on. I know that hydrochloric acid is inhibited for other purposes than the treatment of oil wells. Today I was reminded of the fact that it was used in the pickling industry. I recall an incident of a discussion regarding galvanizing, and in the case of zinc and iron or steel it is very essential that the mill scale be removed, and that is done by a pickling process. I would say that I learned of that probably six or eight years ago. That would make it about 1928 or 1926. I don't recall that I knew about it before that. I would say that it was about 1926 that I knew about it. I would say that in 1928 it became obvious to me that it was such a simple matter to inhibit hydrochloric acid with arsenic or some other material having the same characteristics and to employ that acid in the treatment of oil wells to increase production. I would say that it more or less became obvious to me immediately after I acquired knowledge of these different facts. I recall of discussing, I don't recall exactly with whom, but discussing the use of acid to more or less dissolve lime. I recall of an instance, of a particular instance where hydrochloric acid was put in a well for the

purpose of dissolving lime. That, however, was principally for the reason of recovering tools that had been lost in the well, and the idea was that the acid would dissolve the lime and more or less free the tools; that is the tools that were lost in the debris at the bottom of the hole.

I have been engaged in the oil production business in one way or another since 1923. I was originally employed by Empire Oil and Gas Company. I was assigned first to the geological department. However, I was located in a field office where the production department was officed in the same building with us, and discussed with the various production department employees the method of pumping and operating properties.

To increase production, if possible, is more or less accepted as one of the problems in the production department of an oil producing company. However, there are and have been times in which economic conditions have more or less retarded that or delayed it for periods of time.

I don't remember the price of oil in 1926 and say to 1932. I believe the price of oil in 1928 was around $1.50 a barrel for 40 gravity oil. The Seminole field came in I believe along in 1927. It was getting pretty well along in 1928. As I associate the years with the oil production I believe it was going very strong in 1928. The Gypsy Company was operating in Seminole, drilling wells in 1928. I don't remember how many wells they drilled there. I rather imagine that at one time they had twenty-five, somewhere between twenty-five and forty-five wells.

The drilling in the Seminole area was not principally to produce an extra barrel of oil or 100 barrels of oil; it was protection for acreage. I believe that you have the wrong reasoning about why Seminole was drilled in place of going into the older properties. The reason was to protect their acreage there. If we had a forty-acre lease, or that is a company had a forty-acre lease and offsets were being drilled to it it would be nothing more than good business to go in and drill and produce oil in proportion to your neighbors and protect your property in that manner. At that time as I recall proration was in effect in the Seminole area

and it was impossible to run all of the oil, but nevertheless it was done so that there was equity in protection of your lease as compared to your neighbor's lease. That same rule or reasoning did not apply to the Glenpool area. There were no offset requirements in the Glenpool at that time. Glenpool was drilled in 1908, 1909 and 1910, if I recall correctly, and the wells had declined to such an extent that those were just operated part time.

I am now with the Phillips Petroleum Company, and have been with them for a little over a year. As far as I know that company was treating their wells with inhibited acid when I first went with them. I do not know when they started to do this. They are doing it at the present time to a more or less limited extent.

I was informed as to how much inhibitor to use in the acid that was employed in this well in 1928 by reading the report previously submitted here from the Gulf Research Laboratory. As to whether or not this problem of treating the well with acid originated with me or first came to my attention and was spread by me, I will say that I was perhaps present when a discussion was made as to the trouble which we were having and suggesting what could be done to remedy the trouble. I do not recall the exact amount of acid that was used in that well. I can say that there were —just guessing at it I would say probably twenty carboys of acid. As I recall the treatment it was all poured in at one time. The well was producing from the Glenn sand and probably around 1500 or 1600 feet deep. The size of the tubing was two inch. I don't recall the size of the casing, probably either what is termed five inch or six inch.

I do not know how much of an accumulation of gyp there was in the bottom of that well at the time the acid was applied. That is problematical. I have seen samples —on the lower of an inch thick and other places on tubing that would be probably an eighth of an inch thick. I haven't seen instances where gyp entirely filled the space around the rod or between the tubing and casing. The deposition of scale is by nature a slow process and in a well that is operating where the rods are moving up and down

it would be practically impossible for the scale to form so that it completely surrounded that rod. Some of those wells in the Glenpool were pumping twenty-four hours at that time; most of them were not. Pumping at that time was of a nature so that any material in solution in the water or oil could precipitate during the intervals between pumping operations. That is no doubt when, perhaps—well I don't know whether it would be when most of the gyp would be deposited. You just naturally assume that in a quiet—or that is water which has an excess concentration of any salt, the quieter it is why that is more or less conducive I would imagine toward the freeing or deposition of the salt out of the water.

The necessity for simultaneous pulling of the rods and tubes in some instances is that when scale is deposited on your—the outside of the working barrel which is known as a liner barrel and more or less made a bond so that it is hard to get it out of the common barrel which is the container into which it is run and if that is left there for a period of time the sucker rods which are pulling the liner barrel perhaps do not have strength enough—they don't like to pull them in two—they will take a strain—the boys will generally have an idea about how much of a pull they are putting on a string of rods and it is detrimental to rods to overstrain them. That is because of this deposition of gyp. The circulation of acid, the circulation of fluid in the well means pumping the fluid in the well up the tubing and discharging it back into the casing. It was flowed or circulated through the tubing back into the casing—the cycle. We never pumped the acid between the casing and the wall of the well. In the normal pumping of the well that would be impossible. As it runs down, the movement in the recirculating of a pumping well, the fluid that is discharged back into the well travels downward in the annular space between the tubing and the casing it would not come up, it would enter the standing valve on the tubing and go down, and then flow in onto the standing valve below the tubing up through the tubing. The idea of doing that of course was to more generally distribute the acid, for we were at-

tempting also to dissolve any gyp or lime which might have been deposited on the face of the sand and that would be one of the methods of doing it. The fluid levels in those wells are quite low and the movement of this—or by circulating the fluid why you would get a better chance of the acid attacking the sand. And then another thing, this acid, I don't recall just what it costs but it was bought in small quantities, probably thirty or forty or fifty cents a gallon and the amounts of scale in a well, of course, it is problematical and still is problematical as to just how much there is and the amount of acid used, you take twenty carboys of acid perhaps would not dissolve it—I don't know just exactly but guessing at it I would say that it would not dissolve over probably four or five cubic feet of limestone. I don't know how much of a cavity there was at the bottom of the well in cubic feet; the wells have been shot pretty heavy.

REDIRECT EXAMINATION

The picture marked Figure 2 on page 589 of Defendant's Exhibit No. 297 looks to me like it is a section of tubing removed from a well with the deposit of scale and you will note here on the inside that the thickness of the scale is not as much as on the outside because the barrel and rods have been run through that several times and any scale that would be deposited there by putting the barrel and the rods down through why it would necessarily be small enough to allow them to go through. The width of the thickness of the tubing in that picture is a little bit less than a quarter of an inch. The width of the calcium carbonate formation or gyp scale formation on the outside of the tubing is a quarter of an inch or five-eighths. I would say that on the inside it would be about a sixteenth of an inch or a little more. The purpose of putting this hydrochloric acid in the well such as that of the Glenpool area was to take the gyp off of the tubing.

RECROSS EXAMINATION

The formation in Glenn Pool is sand, silicious sand.

S. C. KISER,

a witness for defendant, testified in Dow vs. Williams, as follows:

DIRECT EXAMINATION

I live near Kiefer, Oklahoma, and am employed as field foreman by Gypsy Oil Company. I was so employed by them in the Glenn Pool field in 1928, 1929 and 1930, the same place I am now. The Gypsy Oil Company treated wells with what we called muriatic acid in 1928, 1929 and 1930. We treated several wells. We run it through the tubing to remove what is commonly known as gyp, and we also used an inhibitor in some of them and some we didn't. We treated the well to remove gyp so we could handle the rods without so many pulling jobs, and possibly chance of removing corrosion off the sand too.

The Court: Do you know what effect it had, whether it did work or not? A. Well, it just eliminated pulling. In one sense of the word it would increase the production because we didn't have so much down time in pulling.

In the wells where they were treated by pouring inhibited hydrochloric acid down the tubing we run it in tubing with patent barrels, liner barrels, and after it stood the proper amount of time we wished for it to we raised this barrel up and let the fluid pass out on the sand in the well. One purpose was to get it out of the tube and another to eliminate gyp in the sand, if there was any there.

I have records or memorandum showing the dates that some of these wells were treated. These are all the records I have, I have them all with the exception of that one, 1928. I seen that one treated but I didn't keep the record. I have some six here.

On November 7, 1930, we treated one on the William Berryhill Number 8; the same well they had reference to; and March 10, 1931, the same well; and on July 29, 1929, we

treated Well No. 9 on the same lease; and William Berryhill No. 11 on September 11, 1929. That particular one was diluted with rodine. William Berryhill No. 26 on August 5, 1929. This particular well, if an inhibitor was used at all, the best I can remember the name, I wrote down here, is armine; some substance that looked to me like bees wax, 10 pounds of it. William Berryhill No. 1 on July 25, 1930, run six carboys of acid without any inhibitor. Sam Vowell Well No. 3, September 30, 1929; that was run without an inhibitor; and Thomas Gilcrease Well No. 22 September 4, 1929, we used rodine as an inhibitor with that well. J. P. Rhodes Well No. 6 September 20, 1929, we used that one without an inhibitor.

They treated one well on the Birdie Sells lease, but I have forgotten the date. I didn't have anything to do with that one. The reason I know they used that inhibitor is that is what I was told it was for. It was a dark brown substance that smelled very badly. I have not since had occasion to see something that I knew was Rodine No. 2 more than what they told me that is what it was. That was the first time I had seen what they said was Rodine No. 2. The acid we put in these wells is what we always carried as muriatic acid and we kept it in stock and used it for other purposes.

CROSS EXAMINATION

I have no record of how much acid was put in the well in 1928, although I knew there was quite a bit went in, but I have no record of it myself. I don't recall about how much; several carboys though at least, I imagine twenty carboys. An inhibitor was used with the acid on just two wells that we treated in 1929, 1930 and 1931, including that armine. Well number 11, William Berryhill is one of them. That was September 11, 1929. The next one is August 5, 1929. That is the one diluted with that armine. I recall how much acid was used on each of these two wells. The memorandum I have been referring to during my testimony

was taken from those books. I kept the record of it myself. That is a complete copy of the record from those books copied this morning. I didn't bring those in. The memorandum I have is just the same thing as the entries in the book. I have read all the memorandum I have before me in connection with these wells. We haven't treated wells with acid for the Gypsy recently. I am still in the Glenn Pool. The last well we treated with acid in the Glenn Pool is the last one I gave you here. That was on July 25, 1930.

It is hereby stipulated that the following narrative of the testimony of

RUSSELL S. KNAPPEN,

taken from the appeal record in The Dow Chemical Company vs. Williams Bros. Well Treating Corporation may be accepted with the same force and effect as if taken herein:

DIRECT EXAMINATION

I live in Tulsa, Oklahoma, and by profession am a geologist and engineer. I work for Gypsy Oil Company and have worked for Gypsy Oil Company for eight and a half years. In 1928, '29 and '30 I was assistant to Henry McGraw, vice-president of Gypsy Oil Company.

At one time Gypsy Oil Company treated wells with hydrochloric acid inhibited against attacking steel. The

first of those treatments was in 1928, I believe on November 12, 1928. That was the William Berryhill No. 8 in Glenpool. The date was November 12, 1928. The mineral acid introduced into that well was hydrochloric acid. The name of the inhibiting agent that might have been put in that acid was rodine. There were instructions given that the content of rodine in the dilute acid was to be four per cent. We got the rodine from the American Chemical and Paint Company, Ambler, Pennsylvania. I believe that was the first time that rodine had been purchased by the Gypsy Oil Company. It was not the first inhibitor, but the first rodine purchase, however. The reason that we purchased rodine at that time was that it was recommended by the research department of the Gulf Oil Corporation in a letter from Dr. Paul D. Foote, director of the research laboratory, transmitting a report written by Dr. B. B. Wescott.

I had used another inhibiting agent in hydrochloric acid prior to the time we used this rodine on November 12, 1928. From 1920 on we purchased Dearborn Chemical's formula No. 134, which is a hydrochloric acid with an inhibiting agent already in the material. We used that inhibited hydrochloric acid to clean the scale out of cylinder blocks of engines, the acid of course removed the calcium carbonate scale and the inhibitor protected the metal of the engine blocks.

Calcium carbonate is the principal constituent of limestone. It is an essential mineral in limestone. It is one of the common constituents of boiler scale. It is also a common constituent of the scale that collects in radiators of automobiles. There are several different scales but it is perhaps the most common constituent.

I have in my possession a report by Dr. Paul D. Foote, making recommendation with reference to using this rodine. Dr. Foote transmitted the report on July 19, 1928, and it was received by the Gypsy Oil Company in Tulsa, July 21st or 22nd in the due course of mail. I am familiar with the contents of that report. The conclusion of the report is a recommendation on page 18 which reads, "I recommend

that the removal of the scale by use of hydrochloric acid and four per cent of rodine number 2, or other inhibitor of equal effectiveness, be tried in one well of the Glenpool." That is the summary of the report. That report contains a rather elaborate discussion of inhibitors, the composition of the inhibitors and the chemical theory on which the inhibitors are based. It refers to the various sources of inhibitors, describes two that appear most satisfactory, and contains a table showing the result of tests of two inhibitors in various concentrations and at various temperatures on the amount of steel dissolved from plates immersed in hydrochloric acid. That report or investigation happened to be made in this way. Mr. C. P. Dimit, who is production superintendent of the Gypsy Oil Company, in February or March—in February, 1928, told me of this problem, and at that time I was a member of the staff of the Gulf Corporation in Pittsburgh. At his request I went—he sent samples of the so-called gyp or scale from the Glenpool well in to Pittsburgh to the research laboratory with the request for a recommendation from the research laboratory of some material which could be used to remove the scale from the wells and the well equipment. Dr. Foote recommended the use of acid plus rodine. In the meantime I had been transferred from Pittsburgh to Tulsa and I believe it was on June 4th, I wrote to Dr. Foote stating that we were very doubtful about the ability of an inhibitor to successfully protect the casing which was very old and in very bad condition, and thereafter Dr. Foote sent us samples of steel tubing some of which had been immersed in raw acid and others in acid containing inhibitors to convince us that we could put this acid into our wells without damage to the casing, tubing and the other equipment.

After the treatment of this first well and prior to June 30th, 1930, there were several other wells treated by the Gypsy Oil Company with this inhibited hydrochloric acid. These wells were all located in Glenpool.

Dearborn 134 was inhibited hydrochloric acid. I am not certain that it was labeled inhibited hydrochloric acid; it was labeled scale remover. I cannot say as to whether or

not other oil companies had used it extensively for the purpose for which the Gypsy used it. I know that the Gypsy made purchases each year from 1920 to 1928. I believe that an analysis of Dearborn 134 to determine whether it was sufficiently inhibited so it might be used to remove calcium carbonate scale without injuring the pump jacks and the cylinder jackets and the wells was made for the Gypsy Oil Company in 1921. We had an analysis and test made at the laboratory in Pittsburgh in 1929—I beg your pardon, 1930, to determine whether it was sufficiently inhibited to protect admiralty metal, which is brass, and much more susceptible to corrosion than steel.

I know Mr. Roy Ginter. In 1921 Gypsy Oil Company paid him a fee for chemical work. The record simply discloses analytical work $15, investigation of organic matter $35; I was not connected with the company at that time, and don't have personal knowledge.

Use of the inhibited hydrochloric acid in the wells of the Glenpool by the Gypsy Oil Company was scientifically successful, but economically unsuccessful, because the acid was costing us forty cents a gallon and we were dealing with small wells at a time when the price of oil was very low. It saved money in the operation of the wells over what it cost to operate them without using the acid. I believe there was some increaase in production by use of this acid rather than our old cleaning-out method, but I cannot put my finger on precise figures because the wells were pumped into a lease tank battery so that many wells were produced into the same tank.

These particular wells were all produced from the Glenn sand. That is a sand.

After this acid had been put into the casing or tubing it was of course pumped out of the well eventually. When it was pumped into the casing of course it went to the bottom of the well and it was there pumped out. Where it was placed in the tubing, as I understand in each case, the valves of the pump were unseated to let the acid run down into the cavity at the bottom of the well to remove scale from the walls of the well. That would be calcium car-

bonate scale, or as a field man calls it, gyp. The same calcium carbonate that is the principal limestone formation. There are other impurities there, but primarily calcium carbonate.

I met a Mr. Cummin with the Dow Chemical Company. I believe it was in October or November of 1930. I was entirely wrong; that was November 28, 1932, Mr. J. A. Cummin called upon me. I understood he was district manager for Dowell, Incorporated. I discussed with him the general subject of acidizing. We did not do any business that resulted in any money changing hands.

There was no suit about this patent at that time. He stated that his company had a patent covering the use of an inhibited acid for treating oil wells and solicited business from me. He claimed that his patent was valid and covered the use of inhibited hydrochloric acid in an oil well. I advised him that the Gypsy Oil Company had used inhibited acid as early as 1928 in oil wells, exhibited to him the report which has been entered here this afternoon, and also our correspondence file, and told him that under those circumstances I did not believe his patent was any good, admitting that I was an engineer and not an attorney.

The Gypsy Oil Company since June 30, 1930, surely has continued to use inhibited hydrochloric acid in oil wells, down to the present date. To my knowledge the Gypsy Oil Company has never been sued by the Dow Chemical Company for alleged infringement. I stated to him that we would continue to use inhibited acid.

(Here the report referred to by the witness was offered and received in evidence as DX-151.)

There are various ways of making hydrochloric acid. Frequently hydrochloric acid in its raw state has impurities in it. Probably the most common impurity is sulphuric acid. Very frequently it has impurities such as arsenic in its raw state. The trade in ordering chemically pure hydrochloric acid certainly does require the arsenic content to be greatly decreased from that usually found in hydrochloric acid. Whether or not in the purchase of commercial hydro-

chloric acid it is a common requirement to limit the arsenic content of the hydrochloric acid first would depend on the purpose for which it was being used. In our service we have never made any specifications. I believe it is generally understood that the general run of hydrochloric acid in the raw state has arsenic present in the solution.

CROSS EXAMINATION

I have been engaged in one capacity or another in the oil business since 1920. I am a sort of a chemist. I am not a professional chemist. I took five or six courses. I went through organic and physical chemistry in the university.

All the chemical problems of the Gypsy Oil Company have come under my supervision since 1928. I did not have such problems submitted to me prior to going with the Gypsy Oil Company.

From 1920 to 1926 I was a member of the Oil and Gas Section of the United States Geological Survey. I wrote papers for the survey on geology and natural resources and mineral resources of an area southwest of Billings, Montana; and another paper on the geology of the Phienic area, Alaska.

Petroleum oil is generally classified as a mineral.

I have also been active in connection with the producing end of the oil business since I joined the Gulf Oil Corporation in 1926.

I did not personally observe any treatment of an oil well with hydrochloric acid during the year 1928. I have never seen an oil well treated with hydrochloric acid. I got my information for my testimony regarding treatment of an oil well with hydrochloric acid as an assistant to the vice-president in charge of the technical work of the company. All the technical reports pass over my desk. This report of the well treatment in 1928 was in writing. I have a copy of it right here. The treatment of this well in 1928 was the first treatment of a well with hydrochloric acid that ever came to my attention. I had never treated a well

with hydrochloric acid, either inhibited or not, prior to 1928, nor had I ever made any investigation of such a treatment. No report of such treatment passed over my desk while I was with the Geological Survey.

The problem on which the recommendations by Dr. Foote and Dr. Wescott were made originated in Tulsa. Mr. Dimit raised the question with me in the course of a visit in 1928. The problem referred to by Mr. Dimit was the large amount of scale which was forming on the face of the sand in the bottom of the wells inside the tubing, on the sucker rods and around the tubing, which made operating conditions difficult and reduced production from the wells. That reference was not made to it in writing. We discussed that in his office. I presume that specific wells were named but the general discussion covered the whole Glen Pool situation. I did not make the request for the investigation by Dr. Foote and Dr. Wescott. The way the organization is handled is that the vice-president in Tulsa corresponds directly with the director of research in Pittsburgh, so I suggested to Mr. Dimit that he take that question up with the research department. He then wrote a letter to our vice-president in Tulsa, who in turn sent a letter direct to the research department in Pittsburgh and transmitted the samples to the research laboratory. Samples of scales and samples of water from wells were submitted with that request. I didn't get the samples of scales but they were taken from the rods or tubing that were pulled from those wells. The water samples were brine from those wells under investigation.

The report or recommendation of Dr. Foote and Dr. Wescott was based upon the request made by Mr. Dimit following his discussion of the problem with me and their laboratory investigation made in Pittsburgh by the research laboratory of the Gulf Oil Corporation of which Dr. Foote was the head and Dr. Wescott in charge of the work. The Gypsy Oil Company is a subsidiary of the Gulf Oil Corporation. The Gulf Oil Corporation is not the same as the Gulf Production Company. The Gulf Production Company is a

subsidiary of the Gulf Oil Corporation, just as the Gypsy is a subsidiary of the Gulf Oil Corporation. The Gulf Production Company and Gypsy Oil Company frequently but not necessarily work together on problems of this kind. That is to say, the Tulsa office controls the Gypsy operations and the Houston office the Gulf Production Company's operations. Many problems will be discussed in one office that are not referred to the other. The problems on which a decision has been made in one division which will be helpful in the other are frequently discussed back and forth between the subsidiaries.

The Dearborn Chemical Company's compound came to my attention I believe in 1929. No, it was on December 12, 1931, I wrote Dr. Foote regarding that. I have known of the Dearborn Chemical Company's seliing boiler compound for more than twenty years. That is the first time 124 came to my attention. I had never heard of 124 so far as I know before 1931. I have known of hydrochloric acid being inhibited to prevent its attack on metal about six years. If I had ever heard of that before the incident of this well treatment came up it has now slipped my mind; I don't have any recollection of it.

From the discussion of the trial today I should judge inhibited acid has been employed in connection with the metal pickling business for a matter of twenty-five years. Oh, yes, I have heard of metal pickling before today. I knew of a process in metal pickling before today. I first learned of that I believe in 1929. If I ever heard of metal pickling before 1929 I have forgotten. I didn't learn of that while I was taking my course in chemistry, or in connection with my work in the oil fields. I don't believe I ever heard of metal pickling until 1929. I had experience with inhibiting acid in 1928 but never before that time. I believe that I first learned that hydrochloric acid could be inhibited from that report. No, it was a preliminary letter which came along in April or May of 1928. This knowledge of the use of inhibited hydrochloric acid in connection with the well in 1928 was not confined to me and Mr. Dimit, insofar as the Gypsy organization is concerned.

All correspondence to the executive department is circulated between all the members of the executive department. There were six or eight of us on the tenth floor and the report went down to the production department; went into the engineer's department files; was discussed with Mr. Case, the gentleman that just testified here, our chemist. A copy of Dr. Wescott's report went to our production department. Mr. C. P. Dimit was superintendent of production at that time, in 1928. I presume that report was made a matter of record there in the production department. I wouldn't want to say it was but I presume it was. I believe there is a copy in the production department files. I discussed it with Mr. Case, our chief chemist; with Mr. Wright, with Mr. Smith, division superintendent, Mr. Trax and Mr. Dimit. Also discussed the matter with F. W. Karr.

I don't know of my own knowledge that this 1928 treatment resulted in any increase in production. Some of the boys thought there was an increase and others thought there was no increase except as we procured more continuous operation of the well.

The purpose of giving that well treatment was both to increase the production from the well and also to reduce the amount of operating trouble in the well. If we could remove the scale from the face of the sand we could increase the production. If we could remove the scale from the inside of the rods and tubes and the pump we could decrease the amount of trouble we had with the well. I don't say that I have a better recollection than the man applying that treatment as to the result secured from it as shown on this report of the production department. I didn't see the operation. The record there is the best record of course. If this report said that when the acid treatment was applied the well has pumped satisfactory but the production has not been increased, that was the opinion of the man who did the work, the man who wrote that report. If in this report it says, no pulling jobs have been necessary for gyp trouble, but the time has been too short to draw any definite conclusions as to the effectiveness of the treatment,

what he refers to by pulling jobs is that the scale precipitated from the water inside the tubing, it forms around the sucker rods, pieces of that scale will chip off and fall down into the pump and wedge the valve open so you couldn't pump it. It might be necessary to pull the well to repair the pump. In other cases the scales might accumulate so you couldn't move the rods up and down in the tubing, and it is necessary to pull the rods out in order to clean off that scale. I don't know of my own knowledge whether all those conditions were present at the time.

How much acid was put into the well in 1928 is set out in the report. I didn't do the work and I wouldn't want to testify. I think there are about twelve gallons of acid in a carboy.

I have testified that I have never seen a well treated with acid. It has been done under my supervision but I have never seen a well treated. After this incident in 1928 two wells were treated with hydrochloric acid, inhibited or not, in 1929, also in the Glenn Pool. I am not certain as to whether in those treatments the acid was put down the tubing or down the casing. I believe there was three wells treated in 1929. I don't know how much acid was put in them. I can't tell you how many wells were treated in 1930. It is probably in the files here but it is one of the many details that I don't carry in my mind.

I have a further report relating to these treatments in 1929 and 1930. Here is the report. I don't suppose it is the type or kind you want, June 5, 1931, proposing the treatment of some wells in Glenn Pool; and then following it is a report dated July 10, 1931, discussing the treatment of the well in Glenn Pool, to which Mr. Case referred in his discussion. That report is set out here in some detail. It shows the amount of acid employed. July 1, 35 c.c. of hydrochloric acid, 18 c.c. of rodine and 9 gallons of water. On July 2 the same amount of each. July 3, 36 gallons of water, 1400 c.c. hydrochloric acid, 72 c.c. of rodine. July 4, dropped back to the 9 gallons of water and 350 c.c. hydro-

chloric acid. That would be a little less than 10 gallons for each well treatment.

(Here the report dated February 1, 1929, referred to by the witness was offered and received in evidence as DX-152.)

All that I know about treatment of oil wells by the Gypsy Oil Company with hydrochloric acid, inhibited or not, up to that date is reflected in these reports to which I have referred. I mean to well treatments up to 1931.

This report, DX-152, is not the only report subsequent to the February, 1928, report. The first report that I find here is a letter from Stanley Gill of our Houston office to the Tulsa office giving the analysis of the scale in the Glenn Pool. Stanley Gill signed that report. He is employed by the Gulf Production—no, he is employed by the Mellon Institute for the research laboratory; they had a station in Houston at that time. I judge it was Mr. Flynn who referred this matter to Mr. Gill. There is nothing to indicate why the material was sent generally; simply this letter, inclosed find results from analysis of scale from Glenpool. Then the analysis is set out. It does not say from what part of the well the scale came.

The next report is a letter from Dr. Foote to Mr. McGraw transmitting memorandum by Wescott, recommending the use of acid inhibitor. That is a brief memorandum recommending the use of inhibitor in the acid. On June 1, 1928, Paul D. Foote, director of research Gulf Oil Corporation, wrote Henry McGraw, vice-president Gypsy Oil Company, enclosing this memorandum recommending the use of an inhibitor in the acid.

That is the executive file of correspondence up to some time in 1929. I have in addition our production and engineering department files on the matter of acid treatment also.

Here the files produced by the witness were offered and received in evidence as DPX-453.

As far as I can remember there was just one well treated with acid by the Gypsy Oil Company during the

year 1931. I don't know that any were treated in 1930. There were two treated in 1929 and one in 1928. All of these wells were treated pursuant to the recommendation made by Dr. Wescott of the Gulf Oil Company.

After 1931 the Gypsy Oil Company treated some of its wells with acid, either inhibited or not. The first of the subsequent treatments was made on February 10, 1933. No treatments were made with hydrochloric or other acid, with or without an inhibitor, from July, 1931, to February 10, 1933. The Gypsy Oil Company itself did not make that treatment in 1933 that I refer to. It was made by Dowell, Incorporated, which I understand is plaintiff's subsidiary.

The Dow Chemical Company, or Dowell, its subsidiary, has treated additional wells for the Gypsy Oil Company beyond this one that I referred to. I do not have the information as to how many they have treated up to date. Up to November 17, 1933, the date of this report, they had treated ten. The Gypsy Oil Company itself has treated wells with hydrochloric or other inhibited acid since the 1930 date. Since 1930 and up to the present time the Gypsy Company has treated in the neighborhood of 75 wells. The wells treated by the Gypsy Oil Company were treated in the same general way as were those treated for it by Dowell, Incorporated. We used inhibited hydrochloric acid. That was put right into the formation for the purpose of increasing the production. In some cases that actually increased production in the wells in which it was used; in other cases it did not. I cannot give you the average increase in production as a result of that. I can't give you the increase either in daily production or in ultimate production. That work for the Gypsy Oil Company was under my supervision. I have the reports and can produce them.

Those 75 treatments made by the Gypsy were subsequent to the ones made by Dowell, Incorporated, for the Gypsy Company.

REDIRECT EXAMINATION

There were economic or other reasons why the Gypsy Oil Company did not in the year 1928 and '29 further pursue the method of attempting to increase their production with the use of inhibited hydrochloric acid. The cost of acid was approximately forty cents a gallon, making the cost of treatment of any of those wells very high. At that time we had more than two million barrels of Glenpool oil in storage. We foresaw a decrease in the market price and had no desire to increase our reserves and accordingly decided to delay further acidizing operations until we had either a shortage of that grade of oil or a more favorable market.

The reason that Gypsy employed Dowell, Incorporated, to treat certain of their wells was that at that time we did not have our acid treating equipment in shape to do the work; the well was located up in Kansas, remote from the place where we expected to do most of our work and it was cheaper to employ them to treat the well than it was to move our truck and our acid from Seminole.

We have employed others than the Dowell to treat our wells with acid. We have employed the Mid-Continent Chemical, and Independent Torpedo, and the Chemical Process Company. When we employed them it was our understanding that they were to put inhibited hydrochloric acid in our wells. We have learned since that one of those companies did not. It was on that understanding they were permitted to treat our wells. We didn't notice any corrosive effect of the hydrochloric acid after the treatment. We have had no good opportunity to make the inspection.

None of the wells treated by us in 1928 or 1929 or 1930 were in or producing from what is known as a limestone horizon or formation. They were all producing from sand. If the face of the sand was clean there probably would not be any increase in production from treatment with inhibited hydrochloric acid. In this case where we had a scale over the sand we hoped for an increase in production.

RECROSS EXAMINATION

There were two other companies that treated wells with acid other than the Dowell, Incorporated. We understood that all three would use inhibited acid. One company now denies they used inhibited acid in its operation. I don't know whether we have given that company any further busfness. I don't control the letting of the contracts. I don't watch the details of that. In the treatments made by Gypsy Oil Company itself, they have used inhibited acid.

REDIRECT EXAMINATION

The Mellon Institute is an endowed organization. Its researches are publicly known, and the results of them are available to the public, so that this report which came from the Mellon Institute was available to the public at or about the time that I testified we received it.

RUSSELL S. KNAPPEN,

called by defendant in this cause, testified further as follows, by deposition:

DIRECT EXAMINATION

I am employed by the Gulf Oil Corporation and am the same R. S. Knappen who testified in 1934 in the case of The Dow Chemical Company vs. Williams Brothers Well Treating Corporation before the District Court at Tulsa, Oklahoma. I have reviewed the testimony that I gave in

that case as it appears in the printed record thereof. I wish to make a correction or explanation with respect to my testimony as it appears in this printed record. I think that either the reporter misunderstood or I misspoke myself with respect to the reports of the Mellon Institute. On page 111 of the record under the heading of "Redirect Examination," it appears from the record that I gave the court the impression that any report made by an employee of the Mellon Institute was immediately a public record. I do not understand that that is the case. Many Mellon Institute reports are published but the mere fact that a report is submitted to the director, or is submitted by a fellow of the institute to the sponsor of a fellowship at the institute, does not make that report available to anyone who may desire a copy of it at any time. I have no knowledge as to whether this particular report of Dr. Wescott's was ever published.

That is the only thing of importance that I wish to correct in my testimony given in The Williams Brothers case as it appears in the printed record thereof. I would like to point out that at the time I was testifying in the Williams Brothers case, the matters under discussion had all transpired within six years of the trial of that case. Nearly seven years have elapsed since that time. If my testimony today is at variance with the testimony that I gave in the Williams Brothers case, it will only be because of my faulty memory, and my testimony in the Williams Brothers case should be considered as accurate and my testimony of today inaccurate, if there is a discrepancy.

In my testimony in that case I indicated that the Gypsy Oil Company, or the Gypsy Division of Gulf Oil Company, used two other companies to acid treat oil wells other than Dowell Incorporated. And there I stated, "We understood that all three would use inhibited acid." The other two companies I had in mind at that time were the Independent Torpedo Company and Chemical Process Company. I know that the Chemical Process Company has treated a number of wells for Gypsy or Gulf under my direction, and it is my

understanding that inhibited acid has not been used by the Chemical Process Company since the date suit was filed by The Dow Chemical Company against the Williams Brothers Well Treating Corporation. But I do believe Chemical Process Company used inhibited acid prior to that time. Of course, there are other companies that have treated wells for us since the time of the Dow-Williams Brothers trial, and one of these companies used inhibited acid and it is my understanding that the other company did not. The companies I have reference to are the Morgan Chemical Company of Wichita, Kansas, which treated at least two wells for us. And it is my understanding that they used inhibited acid. The other company I have reference to is the Halliburton Oil Well Cementing Company who have treated wells for us and, so far as I am advised, have not used inhibited acid.

The Gypsy Oil Company, as it was known prior to February, 1937, or the Gypsy Division of Gulf Oil Corporation, as it has been known subsequent to that date, have under my direction acid treated certain of their own oil wells. The Gypsy Oil Company treated several wells in the Glenn Pool area, Oklahoma, with acid long prior to the time when limestone or dolomite wells were treated.

The first acid treatment of a limestone well for Gulf was performed on the Lucy Tiger Well No. 1, in Section 3, Township 8 North, Range 5 East, in the Seminole district, Oklahoma. This well was treated on April 12, 1933. This well was treated by Gypsy employees using Gypsy equipment. In the course of the next 18 months 69 acid treatments were administered to wells by Gypsy employees with Gypsy equipment. Some of these treatments may have been second or third treatments on wells previously treated and I do not know how many individual wells were treated. I believe inhibited acid was used in this work throughout 1933, but subsequent to the filing of the Dow vs. Williams suit Gypsy ceased the use of inhibited acid and treated its wells with uninhibited acid. I do not now regard the use of an inhibitor as necessary to the successful acidization of

an oil well. At the time we started this acidizing work we believed that inhibitor was necessary, but in the course of a year's experience we came to the conclusion that the inhibitor was costing us more money than the damage to the equipment would have amounted to, had we used raw acid. Accordingly, we were at the point of stopping the use of the inhibitor when Dow filed suit against Williams.

I recall why we used inhibiter on the first treatment; it was because of the fear of all oil men that acid would damage the casing, tubing, pump and other equipment in the well. Dr. B. B. Wescott, a fellow of the Mellon Institute, in a report about July, 1928, had recommended the addition of an inhibitor to acid which was to be introduced into any Gypsy oil wells. This is the same Dr. Wescott that is now with the Gulf Research and Development Company. It was due to correspondence with Dr. Paul D. Foote, who was Dr. Wescott's superior, and to Dr. Wescott's reports which were transmitted to us that we used inhibited acid.

I was in charge of whatever acid work was done by Gypsy in the years 1928, 1929 and 1930, endeavoring to carry out the suggestions of Dr. Westcott's report dated about July, 1928, in that I was an assistant to the vice president of the Gypsy Oil Company at Tulsa, Oklahoma. I was in charge of all technical work of this company, and with Mr. C. P. Dimit, who was general superintendent of the company, I discussed these acid treatments and suggested the desirability of making them. With Mr. Dimit's approval, I had direct contact with the chief engineer of the Gypsy Oil Company and with the chief chemist of the company, who was in the geological department. Also, I talked directly with the chief chemist, with the approval of the chief geologist, and while I did not have the power to hire or fire these employees, they did accept every suggestion that I made. I think I can fairly say that I was in charge of this acid work, and the reports on the work all came across my desk. The reports were made to the chief geologist and to the general superintendent, in accordance with company policy, but they were immediately trans-

mitted to me, and of course, there were many telephone reports and conversations concerning this work which I received direct.

The Gypsy Oil Company treated with acid certain wells on the Berryhill lease in the Glen Pool, Oklahoma, and subsequently thereto, treated a well on the Anderson lease in the same oil field to carry out a recommendation made by Mr. Case. The William Berryhill well No. 8 located in the Glenn Pool, Oklahoma, about 15 miles out of Tulsa was treated on November 12, 1928, with 9 carboys of hydrochloric acid, which is approximately 108 gallons of acid, to which was added 4 per cent Rodine. Rodine was an inhibitor which we purchased for addition to the acid to prevent any damage to the well tubing, casing or pump. This well had caused considerable trouble due to the deposition of what is colloquially known as gyp in the well.

The reports on this Berryhill well No. 8 repeatedly showed the deposition of gyp in the well tubing immediately above the pump. The gyp would interfere with the removal of the pump from the well and occasionally pieces of scale, which we call gyp, would break off from the tubing and fall into the pump and interfere with the operation of this well. The records of this well show that the gyp was accumulating in largest volume close to the pump and in decreasing volume upward for a distance of 400 feet above the pump. We have no direct knowledge on this particular well as to whether or not any deposition of gyp occurred on the face of the sand formation of the well, but we assume that there was because wells that deposit gyp in the tubing commonly would deposit gyp on the face of the sand.

I was not present at the William Berryhill well No. 8 or at the Jacob Anderson well No. 3 when either of these wells were treated. As I stated before, 9 carboys of hydrochloric acid with 4 per cent of Rodine were introduced into the casing of the Berryhill well No. 8 on November 12, 1928. The next day approximately 18 gallons of acid with 4 per cent inhibitor were poured down the well tubing. The

well had failed to pump after the acid had been poured down the casing and it was concluded at a conference that probably some gyp loosened by the acid had gotten into the pump. Accordingly, the 18 gallons of acid were poured down the tubing in order to remove gyp from inside the tubing and from the pump. There was some difficulty in getting the well to pump. It was interpreted by all concerned as meaning that there was still gyp or scale in the pump and the rods were lifted and dropped several times in order to force the pump into proper position. Then, an additional carboy and a half of acid, with inhibitor, was added to partly fill the tubing. This acid was allowed to stand in the tubing for a day and then pumping commenced. A report was written on February 1, 1929, stating that since the acid treatment the well had pumped satisfactorily, with no gyp trouble. Previous to the acid treatment, the well had caused trouble because of gypped tubing in March, July, September, and November of 1928.

The Jacob Anderson well No. 3 is located in the Glenn Pool, Oklahoma, not far from the Berryhill well No. 8. The large volume of acid and inhibitor used in treating the Berryhill well No. 8 was expensive. The chief chemist of the Gypsy Oil Company, Mr. L. C. Case, thought that he might eliminate the use of such a large volume of acid and secure equally satisfactory results by putting in small quantities of acid day by day. Accordingly, on July 1, 1931, the treatment of Anderson well No. 3 was started, using approximately 9 gallons of water and 350 cubic centimeters of hydrochloric acid and 18 cubic centimeters of Rodine which is the inhibitor previously mentioned. The plan was to gradually introduce each day this Rodine, acid and water. The treating solution was fed into the well gradually at the end of the day's pumping and was put into the casing of the well with a 17-foot length of hose so that the acid would surely go down the well casing and not be removed from the well by the vacuum which was pulling gas out of the well at all times. The treating solution was dumped into the casing at the end of the day's pumping and allowed to

stand over night in the well. The thought was that this would give ample opportunity for the acid to spend itself in the well and it could be pumped out with the oil and water produced by the well the next day.

We had conferences to determine what treatments were to be administered to these wells. The ultimate purpose in the treatment of the Berryhill well No. 8 and the Anderson well No. 3 was the same, but the thought was that by using a small amount of acid daily in the Anderson well, it would be possible to get away from the very heavy expense involved in a single batch treatment, such as was used on Berryhill No. 8. The production department had objected to the batch treatments, saying that a big treatment, such as was given Berryhill No. 8, cost approximately $260 and that the cost of well trouble in the well over a year or two was considerably less than that amount. Accordingly, we were endeavoring to develop means of treating these wells at a low cost, which would still get away from the well trouble that we were experiencing. There were conferences held in my office prior to each of these treatments, at which conference engineers and a chemist were present. In those conferences, I would not say that I designed the treatment. I took part in the discussion and don't now remember how much I contributed to the program and to what extent. I was simply approving the program, but I called the conference in each case. I was present during the discussion, and I approved the program before it was adopted.

The treatment of the Berryhill well No. 8 was a complete success from the standpoint of well trouble, and there was no subsequent gypped tubing in this well for many months. I do not remember when the first trouble appeared in this well after the acid treatment. The treatment of the Anderson well No. 3 was not successful. We attributed this lack of success to the fact that there was a great deal of gyp on the inside of the casing, on the face of the sand, and that the acid was neutralized or exhausted before the acid got into the bottom of the pump. We considered the possibility of increasing the amount of acid, but finally dropped

the matter because it appeared that again we were running into more expense in treating the well than the cost of the well trouble.

Q. I wish to inquire as to whether there was any particular secrecy maintained in treating any of these wells which your company treated in 1928, '29, '30 or '31, that is, was the method or whatever you did there purposely kept hidden? A. No, it was not.

There was no particular secrecy maintained while treating any of these wells in 1928, 1929, 1930 or 1931. The treatment on these wells was understood by the pumpers on these wells and it was discussed freely throughout the office. There were no instructions given to the purchasing department to keep secret the fact that we were buying either acid or inhibitor for these wells. To the best of my knowledge and belief, our people discussed the matter freely, not only among the company employees, but with any outsiders who might learn what was going on. We had a profit motive for treating these wells as we did and treated them in an endeavor to increase the production of the well. We treated the wells in an endeavor to both reduce the well trouble and expense and also in the hope of removing the scale from the face of the sand and thereby increase the amount of oil that the well would produce.

Rodine was the inhibitor that we generally used and it was purchased by the Gypsy Oil Company from the American Chemical Paint Company of Ambler, Pennsylvania.

Under my direction, some of the Gulf Companies today treat formations other than limestone formations with hydrochloric acid. There have been occasional treatments of wells such as the ones I have described here in the Glenn Pool area where we treated sandstone wells. In addition to those wells, we have treated a number of standstone wells in Illinois and Indiana. These sandstone wells carried considerable lime in the sandstone and the treatment was administered with the thought that by removing the lime from the sand we would enlarge the porous spaces, increase permeability, and increase the fluid production from the wells. These treatments were made with hydrochloric acid.

Q. Is there any difference in the method used in those cases and in the method you employed when treating what might be strictly called a limestone formation?

Mr. Conner: That is going to be objected to until it has been shown that the witness has observed treatments of these additional wells in Glenn pool, Illinois, and Indiana, and was there present and witnessed the treatments and knows of his own knowledge what took place. Until he has done that, he is not qualified to testify what difference there was, and he further is not qualified to testify what difference there is in these later treatments and the earlier treatments, because he wasn't present, hasn't observed, has no first-hand knowledge of even the earlier treatments in the Glenn pool back in the years allegedly made, in 1928, '29, and '30.

Mr. Babcock: Well, I don't believe you understood my question, Mr. Conner. I am now comparing present day treatments of sandstone, having calcareous material in them, with what might be truly called limestone formations.

Mr. Conner: I still think it has not been shown yet in the record, to my knowledge, that the witness was present and observed these later treatments, even though the wells that were treated had any formations having calcareous material.

Q. (By Mr. Babcock): I will ask the witness, have you ever seen a well acidized? A. No, I never have.

Q. You have directed the treatment, is that correct? A. I have. I have instructed our engineers to acidize various wells.

Q. Have you gone into detail with them, as to what methods should be employed? A. I have had repeated conferences as to the amount of acid and the pressure to be used, time that the acid should be left in the pay, or in the well, and the general method of acidizing.

Mr. Babcock: I believe that qualifies you to answer that question, so I will ask the reporter to read it to you again.

The Reporter: Question: Is there any difference in

the method used in those cases and in the method you employed when treating what might be strictly called a limestone formation? A. In treating the Aux Vases, Palestine and Cypress sands in Illinois and Indiana, the method is identical with the method used in treating limestone or dolomite wells. Of course, the treatments in the Glenn pool area have been treatments with very much smaller quantities of acid.

Q. Is there any other difference between the treatments in the Glenn pool area in 1928 or '29 and the treatment you employ today in treating the limestone formation other than the amount of acid used?

Mr. Conner: Same objection as previously made.

A. Yes, in the treatment of limestone wells, almost invariably the hole is filled with oil or with gas, under pressure, whereas in the Glenn pool treatments there was no attempt to fill the hole with liquid and as a matter of fact we could not fill the hole with liquid, because the vacuum then being maintained on all the wells in the pool makes it impossible to fill any well in the pool with liquid.

Q. Those are the only differences, then, between the two treatments?

Mr. Conner: Same objection.

A. That is correct.

CROSS EXAMINATION

So far as I know, no publication has been made of Dr. Westcott's report apart from its being printed on page 587 of the record on appeal in the case of The Dow Chemical Company vs. Williams Brothers Well Treating Corporation.

To the best of my knowledge and belief, the first printed reference to the Gypsy acidizing work done in the Glenn Pool is contained in an article written by M. E. Chapman, which was published in the Oil and Gas Journal of October 12, 1933.

I am by education and training a geologist. The Gypsy oil wells of the Glenn Pool area that I have been dis-

cussing produced oil from the Glenn sand, which is the same as the Bartlesville sand and a member of the Pennsylvanian series. The composition of the Glenn and Bartlesville sands is primarily silica with small amounts of calcium carbonate and clay.

I am familiar with a paper written by Mr. Wilson of the Gypsy Oil Company, in which he discusses the sands of the Glenn Pool and wherein he gives the calcium carbonate content of those sands. I believe Mr. Wilson states that the Glenn Pool sands are 5 per cent calcium carbonate, and from my acquaintance with the Glenn Pool sand I would state that that is approximately correct. I think you might get an occasional specimen of the Glenn Pool sand which would run as high as 7 per cent or 8 per cent calcium carbonate, but 5 per cent would be a fair average figure. I have taken samples of sand from the Glenn Pool and analyzed them in acid to see whether they contained calcium carbonate, and from the reaction of the acid on the sand I estimated that these samples had a calcium carbonate content of from 1 per cent to 4 per cent.

So far as I know, the first well treated by Gypsy in the Glenn Pool with hydrochloric acid, either inhibited or not inhibited, for the purpose of removing gyp from a well was the William Berryhill well No. 8 which was treated on November 12, 1928. So far as I know, there were no other wells similarly treated by Gypsy in the Glenn Pool of Oklahoma during the year 1928. I have no records, reports, or other memoranda which would indicate that any other wells were treated with hydrochloric acid in that year for gyp removal.

I was in charge of this acid work, or directed it, and I am sure that if any other wells were treated by the Gypsy Oil Company in the Glenn Pool to remove gyp during the year 1928 that I would have known about it. So far as I know at the present time, there was only one well treated by Gypsy for gyp removal using hydrochloric acid in the Glenn Pool in 1928. I am confident that that is the only occasion.

During the year 1929 Gypsy treated wells in the Glenn Pool with hydrochloric acid for gyp removal, and an inhibitor was not used on all of them. Inhibitor was used on the William Berryhill well No. 11 treated September 11, 1929, and on the Thomas Gilcrease well No. 22. I will now state the wells treated in 1929 by the Gypsy Oil Company in the Glenn Pool for gyp removal wherein both hydrochloric acid and an inhibitor were employed: These wells were the Berryhill No. 26 treated August 5, 1929; our record is incomplete on this well but it appears that an inhibitor was used; the William Berryhill well No. 11, which was treated on September 11, 1929; in this well an inhibitor was used with the acid; the Sam Vowell No. 3, treated September 19, 1929, in which no inhibitor was used; the Thomas Gilcrease well No. 22 which was treated September 4, 1929, in which an inhibitor was used and the J. P. Rhodes well No. 6 which was treated in September of 1929 and in which no inhibitor was used.

During the year 1929, the Gypsy Oil Company in the Glenn Pool of Oklahoma treated certain wells for gyp removal using hydrochloric acid and an inhibitor. These wells were the Berryhill well No. 26 treated on August 5, 1929; the Gilcrease well No. 22 treated on September 4, and the Berryhill well No. 11 treated September 11; and the other wells that I have referred to as being treated by the Gypsy Oil Company in that area during the year 1929, while they were treated with hydrochloric acid, that acid to my knowledge and records did not contain an inhibitor.

The inhibitor that was used in the treatment of the Gilcrease well No. 22 on September 4, 1929, and the Berryhill well No. 11 treated September 11, 1929, was Rodine. The records show that the inhibitor used in the treatment of the Berryhill well No. 6 on August 5, 1929, was Armine. I have no knowledge of what that material is, and that is the reason I said our record is unsatisfactory. Rodine is sold to us as an inhibitor and was recommended by Dr. Westcott as an efficient inhibitor. I do not recognize Armine as a trade name applied to an inhibitor compound. I do not

know what it is. I do not know, to my own knowledge, whether or not Armine is an inhibitor, for the reason that I do not know what it is.

During the year 1930 the Gypsy Oil Company treated certain wells in the Glenn Pool area of Oklahoma for gyp removal using hydrochloric acid. These wells were the Berryhill No. 1, treated on July 25, 1930, with hydrochloric acid but without an inhibitor, and the Berryhill No. 8, treated on November 7, 1930, but the record is silent as to whether or not an inhibitor was used in this well. I do not know of any wells in the Glenn Pool area of Oklahoma that were treated by the Gypsy Oil Company in 1930 where an inhibitor was used.

During the year 1931 the Gypsy Oil Company treated the Jacob Anderson well No. 3 located in the Glenn Pool area of Oklahoma with hydrochloric acid and an inhibitor to remove gyp from the well.

I don't know of any case where the Gypsy Oil Company treated a well in 1932 with an inhibitor. If such a well had been treated, it would have come to my attention, but in the nine years that have elapsed I could have forgotten it. However, I have no record of any such well.

I was not present at the treatment of any of these wells in the Glenn Pool area that I have referred to, covering the period from 1928 to 1932. I have not been present even to this date when any well was being treated with hydrochloric acid for any purpose. The testimony that I have given, both on direct and cross examination, with reference to the treatment of wells is based solely on letters, reports, memorandums, and possibly oral conversations that I received.

After the Gypsy Oil Company treated the Anderson well No. 3 located in the Glenn Pool, Oklahoma, in July of 1931, wherein hydrochloric acid and an inhibitor were used, the next well that the Gypsy Oil Company treated or had treated using hydrochloric acid, inhibited or otherwise, was, so far as I know, the F. A. Lovett well No. 1 in Section 24, 19 South, 2 West, located in the Ritz Canton Pool in Kansas,

which was treated on February 10, 1933. The well was producing from the Viola lime, a member of the Ordovician series. I would hesitate to say whether or not that formation would be limestone or dolomite. We make no distinction in our reports and well studies. I think in all probability this is dolomite rather than limestone. It is a calcareous formation, as distinguished from a sand formation, such as is found in the Glenn Pool.

This Lovett well No. 1 was treated by Dowell Incorporated and that is the first well that I know of that was treated by or for Gypsy using hydrochloric acid after Gypsy treated the Anderson well No. 3 in July of 1931. There may have been other wells treated at Glenn Pool just as Mr. Kiser treated our wells in 1929 without instructions from the office, but so far as our office records go, the Lovett well No. 1 was the first well treated after the Anderson well No. 3, between which treatments there is a time interval of approximately 19 months. I do not have any records or information which will show that Gypsy either treated or had treated for them any wells using hydrochloric acid, inhibited or not, during this period of 19 months extending from the date of the treatment of the Anderson well No. 3 in July of 1931 to the treatment of the Lovett well No. 1 on February 10, 1933.

I have information concerning the treatment of a Gypsy Oil Company well known as the P. Wieland well No. 1. According to our records, this well was treated for Gypsy by Dowell Incorporated in March, 1933. This well was located in Section 36, 12 South, 16 West, Kansas, and was producing from the Oswald lime, which is a limestone in the lower portion of the Pennsylvanian series in Western Kansas. Our records further show that Gypsy Oil Company's well known as the L. Tiger well No. 2 was treated on March 10, 1933, by Dowell Incorporated. This well was located in Section 3, Township 8 North, Range 5 East of the Seminole district, Oklahoma, and was producing from the Hunton limestone, of probable Devonian age.

We ordered inhibited hydrochloric acid placed in the

Lovett well No. 1, the Wieland well No. 1 and the Tiger well No. 2, when they were treated by Dowell Incorporated for the Gypsy Oil Company.

After the Gypsy Oil Company's Lovett well No. 1 was treated on February 10, 1933, by Dowell Incorporated using inhibited hydrochloric acid, the first acid treatment made to an oil well by the Gypsy Oil Company to a well producing from dolomite or limestone was performed on the Gypsy Oil Company's Lucy Tiger well No. 1, located in Section 3, Township 8 North, Range 5 East, of the Seminole district, Oklahoma, which treatment was performed on April 12, 1933. This well was producing from the Hunton lime and was an offset well to the Tiger well No. 2 which Dowell previously treated on March 10, 1933. The treatment of the Tiger well No. 2 by Dowell Incorporated increased the production from 2 barrels of oil to 10 barrels of oil, and the treatment of the Tiger No. 1 by Gypsy increased the production of that well from 102 to 350 barrels. The treatment of the Wieland well No. 1 by Dowell Incorporated raised the production from 45 to 140 barrels. The Lovett well No. 1 treated by Dowell was increased from 95 barrels of oil to 650 barrels of oil daily production.

As far as I know, the Lucy Tiger well No. 1 treated by Gypsy on April 12, 1933, and the Lovett well No. 1 treated by Dowell on February 10, 1933, were treated in identical fashion. There may have been differences in the amount of acid used.

Prior to the treatment of the Gypsy Oil Company's Lovett well No. 1 on February 10, 1933, by Dowell Incorporated with inhibited hydrochloric acid, there is no prior case, based on my knowledge or records, of the Gypsy Oil Company's treating a well producing from a calcareous formation. From the date of the treatment of the Lovett well No. 1, producing from a calcareous formation, on February 10, 1933, the Gypsy Oil Company has continued to have many of its wells which produce from a calcareous formation treated with acid.

Dowell Incorporated have treated a number of wells for the Gypsy Oil Company since February 10, 1933. Dur-

ing the period of from February 10, 1933, to 1936, Dowell Incorporated treated in those years more than 25 per cent of the wells treated for Gypsy. Over the eight-year period of from 1933 to 1941, Dowell Incorporated has treated between 25 per cent and 30 per cent of the Gypsy Oil Company's calcareous wells treated for the Gypsy Oil Company. The figure I gave you of 25 per cent to 30 per cent was made by a count of our records yesterday afternoon, and according to my best information it is a correct figure. If you want the exact numbers, then Dowell Incorporated made 348 acid treatments for the Gypsy Oil Company out of a total of 1,314 treatments in that period of from February 10, 1933 to 1941. The total figure of 1,314 treatments includes all treatments made to Gypsy wells, whether they were made by service companies or by Gypsy Oil Company.

As to the work done by the Gypsy Oil Company in the Glenn Pool area in the years 1928 to 1930 for the purpose of removing gyp from oil wells, we do not have detailed records reflecting the success or nonsuccess of the gyp removal treatments made to these wells on which I can rely because the wells pumped into a common tank battery with all the other wells on the lease. Our record of success is primarily a record of decreased trouble on the well rather than a record of increase in fluid production. The opinion of some of the field men is that the fluid production did increase.

Whenever, for any reason, a well is not producing its normal volume of fluid daily, or does not pump the normal number of hours daily, we say that the well is in trouble and some repair on the well is indicated. That trouble may involve broken sucker rods, it may involve a bad pump, it may mean that there is something wrong with the engine or some of the other equipment, but well trouble means some difficulty in the operation of the well, and gypped tubing is one of the common types of trouble in the Glenn Pool area resulting in the necessity of pulling the pump, sometimes of pulling the tubing also, in order to clean out the scale, or else remove the scale with acid.

I have no actual run records to show the oil production from any of the wells treated in the Glenn Pool for gyp removal during the period of 1928 to 1931 wherein hydrochloric acid and inhibitor was used, which would show whether or not the production of oil from these wells was increased because there was anywhere from 4 to 16 wells on each of these leases and all of the wells produced into a common tank. The only information as to how much oil is produced from any one well is the judgment of the pumper and I do not trust that judgment sufficiently to wish to testify about it.

I have examined the printed record on appeal in the case of The Dow Chemical Company vs. Williams Brothers Well Treating Corporation within recent days, and especially with respect to pages 331 to 465 wherein are contained a series of letters, memorandums and reports concerning the gyp removal activities of the Gypsy Oil Company in the Glenn Pool area, extending over a period of years beginning about 1927 and ending substantially about 1932. The reports all came to me. There is some correspondence that did not pass over my desk.

The letters and reports appearing in the record on appeal in the case of The Dow Chemical Company vs. Williams Brothers Well Treating Corporation on pages 331 to 465 are the best reports, but not the only reports with respect to the wells treated in the Glenn Pool area by the Gypsy Oil Company during the period 1928 to 1931.

The various pumpers of the Gypsy wells in the Glenn Pool area have advised me that the use of the acid with the inhibitor increased the production, but I do not have information which I consider sufficiently reliable so that I wish to testify about it. Some of the pumpers and men in the field offered to me the statement that these tests wherein hydrochloric acid and inhibitor were used to remove gyp did increase the production of the well. Other of these men offered me the information that such treatment did not increase the production of the well. It is because of that conflict in report and because of my knowledge that

there was inadequate information that I do not want to make a statement as to whether there was increase or otherwise in production.

A copy of Dr. Wescott's report which appears on page 587 of the record on appeal in the case of The Dow Chemical Company vs. Williams Brothers Well Treating Corporation was submitted to Mr. C. P. Dimit, who was then general superintendent of production for the Gypsy Oil Company. A copy of the Westcott report was also submitted to Mr. L. C. Case, chief chemist of the Gypsy Oil Company. Mr. Dimit's copy was transmitted by him to Mr. R. L. Wright, chief production engineer for the Gypsy Oil Company and this copy was then transmitted by Mr. Wright to Mr. F. W. Karl, who was a chemical engineer on Mr. Wright's staff. I do not know whether or not Mr. F. R. Smith, who was division superintendent for the Gypsy Oil Company in charge of Kansas and northern Oklahoma wells, ever saw the report or not. To my knowledge, I know that the Westcott report was seen by W. B. Wilson, chief geologist; by Henry McGraw, vice president and general manager of the company; by K. Winship, who was assistant to the vice president; by Rush Greenslade, who was another assistant to the vice president, and by Mr. S. C. Kiser. I suspect that the report was seen by a good many others too but those are all the men I can name that I now know saw the report. I might add that Mr. M. E. Chapman, who was my assistant, also saw the report.

Mr. Conner: Were these men who saw this report, in the aggregate, qualified as geologists, chemists or production engineers, or working on production problems? A. Well, the general superintendent, the production engineer, were certainly qualified. The chief geologist is not a qualified production man. The vice president and the two assistants to the vice president that I named are not geologists, but well acquainted with production problems.

I know that the Gypsy Oil Company, prior to 1928, owned and operated oil wells wherein the oil was produced from a calcareous or limestone formation, which wells were

located in Kansas and Oklahoma. In Kansas, the Gypsy Oil Company had 20 wells producing from a limestone formation which were located on the Shumway lease at El Dorado, and we had one well on the George Jennings lease and one well on the Martin lease in the Rainbow Bend Pool. So far as I can ascertain, these are the only calcareous formation wells which were producing oil prior to 1928 in Kansas. The Gypsy Oil Company still owns and operates at the present time many oil wells which are producing oil from a calcareous or limestone formation, and these wells are located in the states of Oklahoma, Kansas, New Mexico, Illinois, Michigan and Kentucky. The Gypsy Oil Company from prior to 1928 up to the present date, owned and operated oil wells which produced oil from calcareous or limestone formations. We have wells on the Shumway lease at El Dorado, Kansas, which were producing oil in 1926 and are still producing. We have one well in the Glenn Pool area in Oklahoma on the Albert Gray lease which was producing from a lime formation before 1928 and is still producing, and we have one well in the St. Louis district of the Seminole Pool, Oklahoma, which was producing oil from a lime or dolomite formation before 1928 and is still producing. I cannot name any others.

With reference to wells treated by the Gypsy Oil Company after the filing of the suit by The Dow Chemical Company against the Williams Brothers Well Treating Corporation, I never took any samples of the acid as it was being introduced into the well or just prior to its introduction to determine whether or not it was inhibited. I never saw a well treated and I never took a sample of acid. I know that such samples were frequently taken. I gave instructions to take a sample of acid from every well that was treated over a period of three years' time and they were taken and reported to me.

REDIRECT EXAMINATION

From 1928 to 1931, the Gypsy Oil Company treated some half-dozen or more wells for gyp removal. We would not have continued to do that if we had not thought it was doing some good. We felt sure that we were accomplishing the desired results. Our question was whether it was saving us enough money to justify the work.

I was not in 1929, nor at any time prior thereto, familiar with the patent to Frasch No. 556,669.

RECROSS EXAMINATION

During the years 1928 to 1931, the Gypsy Oil Company treated four or perhaps five wells in the Glenn Pool area of Oklahoma for gyp removal, using hydrochloric acid and an inhibitor. The last date on which a well was treated using hydrochloric acid and inhibitor for gyp removal during that period was on July 9, 1931. And thereafter until February 10, 1933, so far as I know, no other well owned or operated by Gypsy was treated for any purpose using either hydrochloric acid or hydrochloric acid and an inhibitor. I should modify my previous statement. The record I was looking at was incomplete. I said July 9, 1931, was the date of the last treatment. The actual date was July 20, 1931. That difference is probably not material. There was a period of 18 months and 21 days during which no treatment was made insofar as I know.

REDIRECT EXAMINATION

After the period of 18 months and 21 days, we began employing Dowell Incorporated, the Independent Torpedo Company and Chemical Process Company to acid treat wells for the Gypsy Oil Company. We first employed Dowell Incorporated on February 10, 1933; we first employed the Independent Torpedo Company on March 3, 1933, and we first employed the Chemical Process Company on March 26, 1933.

BLAINE B. WESCOTT,

a witness called by defendant, testified as follows:

DIRECT EXAMINATION

I am in the position of chief of materials and production, chemistry division of the Gulf Research Laboratory. I have been associated with the Gulf Research Laboratory ever since their organization. It started as a fellowship in Mellon Institute in the summer of 1927. The fellowship at Mellon Institute was installed by the Gulf Oil Corporation as a production fellowship in the summer of 1927 and it continued functioning as a fellowship of the Mellon Institute until, I believe, January 1, 1930, when the production research department of the Gulf Production Company at that time was organized. We then moved to our new laboratories on Craft Avenue. Since that time, it has been known as the Gulf Research & Development Corporation and subsequently as the Gulf Research & Development Company. I have been continuously doing research for one or the other of these companies all during that period.

I have a doctor's degree in chemistry, obtained from the University of Pittsburgh in 1923. I did work in connection with the steel industry prior to 1927, beginning first in 1912. I can't say definitely, but it was approximately 1920 when I first heard, to the best of my recollection, of the use of inhibitors to protect metal from the action of acid, such as hydrochloric acid. I know such inhibitors were in common use in the steel industry prior to 1927.

I made the report beginning on page 587 of the printed record of the case entitled "Dow Chemical Company vs. Williams Bros. Well Treating Corporation," which was before the Tenth Circuit Court of Appeals of the United States, Case 1285. I have the original report from which this printed record was taken.

(The report was introduced in evidence as DX-151.)

This report was made approximately June 5, 1928, or slightly before that. I don't know exactly the right date on which it was completed. The letter which is printed on page 344 of the Williams Bros. record assists me in fixing the date. That is the letter of transmittal of this report to Mr. McGraw, of the Gulf Oil Corporation in Tulsa. I can state independently of the report that the method of scale removal contemplated in 1928 involved the treatment of the well with inhibited hydrochloric acid. The report itself discusses the method I have just referred to. The scale that I wished to remove was deposited in both the tubing and the casing, inside and outside the tubing in the well.

Mr. Owen: You, personally, don't know these facts, do you, Doctor? A. That is right. However, the facts are definitely stated in company correspondence which is here for your examination.

Q. And the information you have regarding the subject you obtained either through reports or correspondence which came to your attention, or through verbal statements made to you by others? A. Not verbal statements.

Mr. Babcock: I think we had better go back a little bit, and I will ask the witness to give a little history as to how it happened he was working on this problem or the problems mentioned in this report. A. We were working on problems mentioned in the report because of the written request of Mr. McGraw, who is operating vice-president of the Gypsy Oil Company, a subsidiary of the Gulf Oil Corporation at Tulsa. Here is the original letter signed by Mr. McGraw and the letter by Mr. Dimit referred to there is right behind it (producing papers).

It is stipulated between counsel that wherever letters appear in the Williams Bros. record and are also produced here, we use the ones in the Williams Bros. record; that the letter from Henry McGraw to Dr. Foote appearing on pages 337 and 338 of the Williams Bros. record should be dated March 7, 1928, and that it may be used in lieu of the letter here produced by the witness; that the letter from Mr. Dimmit to Mr. Knappen of January 13, 1928, which the wit-

ness has produced, is the same as the printed letter appearing on pages 333 and 334 of the Williams Bros. record; that the letter beginning on page 337 of the Williams Bros. record was signed by Mr. Henry McGraw, and that the letter in the Williams Bros. record appearing on pages 333 and 334 was signed by Mr. C. P. Dimmit.

It was my understanding from the correspondence that this gyp was deposited in the wells and caused trouble in producing them and servicing the wells, and it was desired to find first some method of removal of the gyp and, secondly, possibly to find some method of preventing the deposit of the gyp. The immediate problem was obviously the removal of the gyp from the wells. Maybe it should be noted, by the way, that the term "gyp" is an oil field term which was used to describe deposits and it specifically relates to many chemical compounds. Like a lot of other oil field terms, it is something that was coined to describe that material.

In the report beginning at page 590 of the Williams Bros. record under "Conclusions," appears this statement:

"8. The release in pressure probably occurs at the surface of the sand in the well cavity, in which case it is reasonable to suppose deposition of more or less of the scale on the surface of the sand. Therefore, the trial should be well worth the expense for its possible value in increasing the production of the well entirely aside from the object of removing the scale from the pipe."

Mr. Babcock: First I will ask the question whether by that sentence you intended that the report convey the idea that you contemplated using inhibited acid to remove the deposition of scale from the surface of sand in an oil well? A. I did. The report states it very definitely.

Q. And did you have at that time anything in mind other than is conveyed by that statement in the report? A. No, I think the statement is quite clear that the treatment with hydrochloric acid was visualized as possibly doing something beyond the removal of the scale right in the tubing of the well itself. I don't believe there is any chance of

misinterpreting that recommendation and conclusion in the report. I contemplated and the report indicates that I contemplated using inhibited acid for this purpose. The use of an inhibitor was recommended in order to prevent damage to the steel equipment of the well from the acid, more accurately from attack by the acid.

The report indicates what particular inhibitor I contemplated using—that the inhibitor was Rodine No. 2. It is my opinion that the inhibited acid would react essentially the same as uninhibited acid on the calcium carbonate scale. Qualitative tests were made to determine this point. These tests were made during the course of the investigation which lead to this report. Qualitative tests were made and qualitatively there was no apparent effect between the action of inhibited and uninhibited acid on the calcium carbonate scale. Prior to making these qualitative tests, I did not have any knowledge on that point.

I had never had occasion previously to investigate the action of inhibited acid on calcium carbonate scales. In this one particular case, analyses showed that this so-called "gyp" scale was primarily calcium carbonate. The term is broad enough as used in the oil fields, however, to mean almost any kind of a scale.

My knowledge is from the official correspondence relative to recommendations made in the report, not from personal observation. These letters or reports were made to my superior, Dr. Foote, and he turned them over to me. According to official correspondence, the recommendations of the report were followed by the operating personnel of the Gypsy Oil Company at Glenpool. The correspondence shows that the first treatment was made on November 12, 1928, in the William Berryhill No. 8 at Glenpool.

Dr. Foote was senior industrial fellow on the production fellowship at Mellon Institute, and I was working with him at that time. In answering these questions, I am referring to the correspondence file I have before me of the Gulf Research and Development Company. This file is ordinarily kept at the research laboratories of the Gulf Re-

search & Development Company and I have access to their files. The letter of February 5, 1929, appearing on pages 368 and 369 of the Williams Bros. record, was signed by Henry McGraw and it quotes the report signed by F. W. Carl. In other words, the first portion of the letter is a quotation of a report in which the name "F. W. Carl" is typed in. The correct date of the letter is February 5, 1929. That letter was dictated apparently by Mr. Knappen. His initials "RSK" are at the foot of the letter. I recall I first saw this letter of February 5, 1929, within a very short time after its receipt at Mellon Institute. I definitely saw the letter before the end of February, 1929.

Mr. Babcock: It is stipulated that the letter the witness has just referred to is the same as that appearing on pages 368 and 369 of the Williams Bros. record with the corrections noted as to the date and signature.

As described in correspondence, other treatments were made in accordance with the recommendations of this report. I do not have those reports with me, however, but they can be made available. To the best of my recollection, there were other wells treated in the Glenpool, also in the Grand Bayou field in Louisiana, and I am certain that company files will contain copies of those reports.

Mr. Owen: The answer is objected to as secondary evidence. If reports are available, they should be produced.

Those reports are in our files at the Gulf Research and Development Company at Harmarville, Pennsylvania, and possibly also in the files of the Gulf Oil Corporation in Pittsburgh. Copies of those reports would be in the offices at Tulsa, at Houston, and at Shreveport, depending upon in what particular field the treatments were made. The Glenpool field is in Oklahoma, close to Tulsa, and the Grand Bayou is in Louisiana, close to the Red River, I believe. I have no personal knowledge of those treatments. I was not there when the treatments were made. I have been in both the Glenpool field and the Grand Bayou field. I am generally familiar with the methods of production of oil in those fields. The reports stated that inhibited hydrochloric

acid was used in these treatments and the reports are my only source of information.

Mr. Owen: The objection is repeated.

It is my understanding that Rodine No. 2 was used in the treatment of William Berryhill No. 8. If that particular inhibitor was used, it was used on the recommendation of my report. I have not an accurate enough recollection at this time to answer as to having had anything to do with the ordering of the inhibitor or anything of that sort—that is, the order for the manufacturer to ship and so on. The samples which I tested in the laboratory were not ordered formally. They were requested from a representative of the manufacturer and I have here a letter notifying me of shipment of those samples. These Rodines were made by the American Chemical Paint Company of Ambler, Pennsylvania.

Q. Did the reports of these field trials which came across your desk relative to these treatments recommended in your report show that it was possible to cause inhibited hydrochloric acid to react with calcium carbonate in the bottom of a well without seriously damaging the metal in the well?

Mr. Owen: The question is objected to as calling for secondary evidence. The reports will speak for themselves.

A. The reports indicated that the inhibited hydrochloric acid dissolved the "Gyp" in the tubing, and made no mention of any damage to the well equipment as a result of the attack of the acid.

Q. When these reports came across your desk, can you state whether you regarded the field trials as being a sufficient test to determine whether the procedure recommended in your report had been accomplished? A. It was my judgment from the reports that the treatments were in accordance with the predictions in the report.

I have read in the paragraph in Vol. 81 of the Federal Reporter, 2nd Series, beginning with the numeral 3, on page 498, starting "The patentee expended substantial sums—."

Mr. Babcock: In this paragraph which you have just read, I find this statement: "Yet its action for that purpose was exactly contrary to the prediction of the scientists, for it increased the deposit. If the outstanding scientists of the Mellon Research Laboratories forecast the exact opposite of the effect of this inhibited acid in the bottom of an oil well, it must be true that experimentation was necessary to prove that the idea of the inventor would work." Is the conclusion of the court that I have just read to you a correct one? A. The conclusion of the court is not correct.

Mr. Owen: I object to the question and answer as incompetent. The witness is not in a position to answer that question without knowing all the evidence that was before the court in the Williams Bros. case.

A. (Continued): I will qualify my answer in this way, that in my opinion the conclusion of the court is not correct.

Mr. Owen: I further call attention to the following sentence which precedes that which was quoted by counsel in his question: "When the research laboratory of the Mellon Institute, after elaborate experimentation, discovered that an inhibited acid would remove the limestone scale from the pumps and tubing, the scientists then suggested its use to prevent further deposits." I think the entire matter quoted in the question and that which I have just quoted should be considered by the witness before he answers the question.

Mr. Babcock: That is why I asked the witness to read that whole paragraph before I asked the question.

A. (Continued): In considering the previous sentence, I would like to point out that the quotation is in error in the first place in saying that the Mellon Institute suggested the use of inhibited hydrochloric acid to prevent deposition of the scale. That was never suggested.

Mr. Owen: Well, is that the reason that you suggested in your previous answer that the conclusion of the court was in error. A. No.

Mr. Babcock: I prefer that counsel not cross examine until I have finished my examination. I think that this is clearly a cross examination question. And with regard to counsel's objection, I wish to point out it is obvious the court, in making that conclusion, which I quoted in my question to the witness, was interpreting facts based on Dr. Westcott's report. Dr. Westcott did not testify in that case, but his report was before the court and I am calling this witness for an examination as to facts to determine whether the court correctly interpreted the report.

Mr. Owen: I again call attention to the fact tt the only information this witness has according to his own statements is that obtained from the reports, some of which have been identified during his examination and others which were before the court in the Williams Bros. case have not been referred to.

Mr. Babcock: If counsel will point out those reports, I will determine on this examination if this witness is familiar with them.

Mr. Owen: Without undertaking to point out every report that was printed in the Williams Bros. record, I call attention to the report which is printed on pages 367 and 368 of the record dated February 1, 1929.

Mr. Babcock: In the statement of the court which I just quoted, it says: "If the outstanding scientists of the Mellon Research Laboratories forecasted the exact opposite of the effect of this inhibited acid in the bottom of an oil well, it must be true that experimentation was necessary—," etc. Now I ask the witness if he is able to find anything in any of these reports which shows that the results obtained were the exact opposite of the forecast made in his report. A. Nothing whatsoever.

Q. In your opinion as a scientist, would the pressure which might prevail in the bottom of a well have any material effect upon the action of the acid on the limestone or of the inhibitor in the acid? A. The pressure on the bottom of the well would have an influence on the rate of reaction of acid on limestone, which would be measurable in amount.

Q. Would it prevent the action of the acid on the limestone? A. If the pressure were high enough, it would greatly slow it down; and, theoretically, it could be high enough to stop the reaction, but that would be at a pressure which is very much higher than is usually encountered in an ordinary oil well.

Q. Would the effect of the pressure be any different whether raw acid or inhibited acid were used? A. I do not believe the presence of the inhibitor would have any influence on the effect of pressure. As far as the effect of pressure on the action between acid and steel is concerned, it is much less than in the case of the action of acid on limestone, and the pressure necessary to stop the action of acid on the steel is very much greater than would ever be encountered in any oil well. It is a matter of millions of pounds, which can be, of course, calculated theoretically.

Q. Referring again to paragraph 3 of page 498 of 81 Fed. 2d Series, is it true that in 1930 or thereabouts experimentation was essential to know the reaction of hydrochloric acid, inhibited or not, under pressure such as might prevail in the bottom of an oil well?

Mr. Owen: You are again asking for his opinion?

Mr. Babcock: Yes.

A. It is my opinion that such experimentation was not necessary.

Q. Is your answer the same, also, in regard to the presence of gases in the bottom of a well? A. I would like to have you state that question more definitely. Just what do you mean by that?

Q. Would experimentation be necessary in order to determine whether the presence of gases at the bottom of an oil well would prevent the reaction of hydrochloric acid on calcium carbonate? A. Only in so far as to determine the effect of pressure. If you are referring to the gases naturally produced by an oil well, the only effect would be in their contribution to the total pressure which was exerted on the system.

Q. In this same paragraph on page 498 of 81 Fed. 2d,

the court apparently quoted this sentence from your report: "The mechanism of the inhibited action is very little understood." Do you agree with that statement that the mechanism of the action of an inhibitor is very little understood? A. Yes, as to the actual mechanism of the chemical reaction, that was a true statement.

Mr. Babcock: The witness has pointed out that in the quotation it reads in his original report: "The mechanism of the inhibitive action is very little understood," rather than "inhibited action."

Q. Is the complete knowledge of the theory of inhibitors necessary for the proper application of inhibitors to indastry? A. No. Such knowledge is not existent even today.

Q. When you made that statement in your report, did you mean to convey the idea that experiments would be necessary to determine whether an inhibitor would protect iron in an oil well? A. No.

Q. The same paragraph on page 498 of the Federal Reporter, Volume 81, 2d Series, further states:

> "When the Research Laboratory of the Mellon Institute, after elaborate experimentation, discovered that an inhibited acid would remove the limestone scale from pumps and tubing, the scientists then suggested its use to prevent further deposits."

Will you please comment on that statement? First state whether you did conduct elaborate experimentation to discover that inhibited acid would remove limestone scale. A. The experiments could hardly be called elaborate. They were comparatively simple. They consisted in establishing the fact that the scale was principally calcium carbonate by analyses; that it was readily soluble in hydrochloric acid, inhibited; and that inhibited hydrochloric acid had very little damaging effect on steel tubing. Prior to these experiments, in so far as I was familiar with the use of inhibitors for this purpose, and since steel tubing is ordinarily a plain carbon steel, I knew that inhibitors would be effective when used in this manner. What I am referring to

is the fact that steel tubing is ordinary steel, and that inhibitors had been in common use in steel mill practice to prevent the attack of acid on the steel. I did know that the use of an inhibitor would protect the steel tubing from the action of the acid. The tests which were made were purely confirmatory of that knowledge. After finding out that the scale was soluble in hydrochloric acid, I did not then suggest the use of hydrochloric acid to prevent further deposits of scale in an oil well.

Mr. Babcock: I notice on page 404 of the Williams Bros. record a certain conclusion in a letter dated July 21, 1931, from L. C. Case to W. B. Wilson with reference to acid treatment in a well known as Gypsy No. 3 J. Anderson. Will you first state who L. C. Case is, if you know? A. Mr. Case was the chemist employed in the geology department of the Gypsy Oil Company in Tulsa.

Q. Is he still employed there—do you know? A. He is.

Q. Who is W. B. Wilson? A. W. B. Wilson was chief geologist of the Gypsy Oil Company at Tulsa.

Q. The conclusion I have reference to is the first one under "Conclusions" on page 404 of the Williams Bros. record, and it seems to indicate that some condition on this well seemed to Mr. Case to be the reverse of the desired result and the reverse of what would happen if the acid were added directly to the water. I would like to have you explain, if you can, these conclusions and state first whether these experiments on the J. Anderson No. 3 had anything to do with the recommendations of your report of July, 1928.

Mr. Owen: May I suggest that the Conclusions referred to be read into the record?

The Witness (reading): "Conclusions. When this treatment was suggested, no trouble was anticipated in getting the acid to the bottom of the well. It has been shown that the acid is being neutralized by scale on the casing, so that, after reaching the bottom, the solution increases the scale-forming compounds in the water. This condition is the reverse of the desired result and the reverse

of what would happen if the acid were added directly to the water."

A. No, they had nothing to do with the recommendations in my report. The difference between the experiment carried on this J. Anderson No. 3 and the treatment recommended in my report was that the treatment recommended in my report was intended to remove scale already deposited in the well, whereas the treatment described in Mr. Case's report involved an attempt to prevent accumulation of scale in the well by continuous treatment of the well with hydrochloric acid. That treatment on J. Anderson No. 3 was an entirely different experiment than I had previously recommended in my report of 1928. I had nothing whatsoever to do with the treatment on that J. Anderson No. 3.

Mr. Case was not connected in any way with the Mellon Institute. This report of mine was made by the Mellon Institute to the Gypsy Oil Company. The relationship, if any, between the Mellon Institute, the Gulf Oil Company and the Gypsy Oil Company is that The Production Fellowship of Mellon Institute was supported by the Gulf Production Company, at that time a subsidiary of the Gulf Oil Corporation. The Gypsy Oil Company was also a subsidiary of the Gulf Oil Corporation.

Q. I have noticed in reading that decision of the Tenth Circuit Court of Appeals in the Williams Bros. case that it is stated a time or two that sand or sandstone was impervious to acid. Will you please state whether sand or sandstone is impervious to acid? A. It is difficult to answer whether sand or sandstone is impervious to hydrochloric acid because of the loose use of the term "impervious." Many sandstones contain various amounts of material that are soluble in hydrochloric acid, and I assume that this is the sense in which "impervious" was used in the question. I make a distinction between the words "impervious" and "soluble." As used in this connection, "impervious" means to me that the acid does not attack sandstone. Hydrochloric acid does attack some sandstones, the amount, as explained above, being dependent upon the composition of each particular sandstone.

The records will show that the Chemical Process Company has been engaged to treat wells of the Gulf Oil Corporation. The records will be available in the district office at Tulsa. Such records are not kept at the Pittsburgh office. From my knowledge of the art of treating oil wells, it is my opinion that inhibited acid is not necessary for successful treatment of limestone in wells. I do not believe the outcome of the treatment as regards an increase in oil production would be dependent upon whether an inhibitor was used in the hydrochloric acid or not.

CROSS EXAMINATION

I received no additional instructions from those given in the letter from Mr. C. P. Dimit to Mr. Henry McGraw, dated February 23, 1928, and the letter from Mr. McGraw to Dr. Foote, dated March 7, 1928, stating the problem which was submitted to me, in connection with which I made the report which is reproduced in the record in the case of The Dow Chemical Company vs. Williams Bros. Well Treating Corporation at pages 587 to 599, inclusive. I did request some further information on the producing conditions at Glen Pool, the request being made in writing. A memorandum dated May 24, 1928, which appears at pages 340 to 341 of the Williams Bros. record, at the bottom of which appears the signature "B. B. Wescott," is the one to which I refer. In response to that inquiry, I received the information contained in this letter of September 27, 1928, signed by Mr. McGraw and written to Dr. Foote. The date my report was transmitted was July 19, 1928. Information to which I have just referred did not reach me until after the report was made. It makes very specific mention of that in the letter. A copy of the letter of September 27, 1928, to which I have just referred, is printed on pages 362 to 364, inclusive, of the Williams Bros. record. That letter was signed by Mr. Henry McGraw and dictated by Dr. Knappen.

Before I made my report, I did not receive any information regarding the problem other than that contained in the Dimit and McGraw letters which are copied on pages

333, 334, 337 and 338 of the Williams Bros. record, except some information relative to the actual receipt of the samples in Pittsburgh. Those were samples of tubing and of water from Glen Pool, according to the correspondence. The illustrations on page 589 of the Williams Bros. record represent the samples of tubing which I received. Those were portions of the samples I received. I don't recall how many samples altogether I received. Page 588 of the Williams Bros. record indicates the samples I received. One of those samples numbered 425 was a sample of the scale from the outside of the 19th joint of tubing, according to that statement. That sample was, roughly, probably about 3 feet long, but I don't recall accurately. It was not separated from the tubing itself, the tubing was there. It was a sample of tubing on which the scale was deposited both outside and inside.

The description on page 588 of the Williams Bros. record was what the figure was intended to illustrate. If you will note, the figure and title says the scale was chipped off at the top to show the thickness of the deposit, and these representations on page 589 are of portions of sample 425. Those sample numbers, No. 425 and No. 426, were numbers given to our laboratory samples, which were taken from these tubing joints submitted to us. Sample No. 425 refers to the scale which was taken off from the outside of the tubing in table 3; sample No. 426 refers to scale which was taken from the inside of the tubing as described in table 3. Those two tables are reproduced on pages 590 and 591 of the Williams Bros. record. The tubing itself was not given a sample number. According to the description of these samples, they came from "Jennie Spocogee Well No. 5:" That was not the well in which my suggestions were tried out, which my testimony this morning showed to be William Berryhill No. 8. It is true as far as the first treatment is concerned, none of the samples of water No. 427-430, inclusive, on page 588 of the Williams Bros. record, came from the well in which my recommendations were tried; as for the subsequent treatments, I would have to look up the records. I don't know if subsequent treat-

ments were made in any of these particular wells or not. It is true as far as treatment in Berryhill No. 8 is concerned.

When I went to work on that problem, my first experience with oil well production problems dated from the inception of the production fellowship in Mellon Institute. That was, I believe, in May, 1927, or June, 1927, which was the date when I went to work for the Mellon Institute on this fellowship. For about a month, I was the only one on that fellowship, I think. Subsequent to that time, Dr. Foote and one other man came, and shortly there were several others. It increased very rapidly from that time on. Dr. Foote was the senior fellow. The Gulf Oil Company or its subsidiaries had two other fellowships at the Mellon Institute when I went to work on this fellowship. One was known as the Gulf Refining Company fellowship, and the other, I believe, was described as the Production Corrosion fellowship. I don't know accurately how many fellows were employed in each of those fellowships when I first became acquainted with them. The Gulf Refining fellowship probably had in excess of ten men. That, however, can be verified from the Mellon Institute records very easily. The Production Corrosion fellowship, I believe had two men. I do not know definitely how long those two fellowships had been established prior to the time when my particular fellowship was established—The Gulf Oil Refining fellowship, for a period in excess of five years, and the Gulf Production-Corrosion fellowship, probably about three years.

The fellows working under those other fellowships were graduate scientists. I wouldn't say as to all of them on the Gulf Refining fellowship, because in common with other fellowships, they had fellowship assistants. Both of the men on the Production-Corrosion fellowship were graduate scientists. Some of them had Doctors degrees in the Gulf Refining fellowship, not in the Production-Corrosion fellowship. They both had Bachelor of Science degrees. These reports that were made by the fellowships, and particularly by my fellowship, were submitted to the donor of

the fellowship. They are not usually published in any printed publication unless by the consent of the donor, I assume. To my knowledge my report was never published in a printed publication aside from its appearance in the printed record of the Williams Bros. case.

Prior to my employment on this fellowship, I had some experience in the steel industry in the chemical laboratories, where I became acquainted with the use of inhibitors. My work in the steel industry had particularly to do with the use of inhibitors in the steel industry. In that connection, I had the work of investigation of inhibitors for pickling work. "Pickling" is a term applied to the removal of scale from hot steel products. That scale would be usually iron oxide. It was never anything else to my knowledge. It is principally iron oxide, there may be slight amounts of silicates in some cases and not always iron oxide. There may be manganese, silicates, silicon oxide.

The principal cause of the formation of scale on iron work which is pickled is from the heating of the iron and processing it. It is not an unavoidable result of heating. It is a common result. There are several purposes for removing that scale in the pickling operation. In almost every case, it is to expose a clean metal surface. It may be done for cold rolling operations afterwards. It may be done as the preliminary to hot galvanizing. Any kind of electro-plating. The further treatment, such as galvanizing or cold-rolling or electro-plating, may or may not generally follow shortly after the pickling operation. Other scale or rust does not very often form on the pickled metals and require their further pickling treatment. It may eventually form if it is stored long enough under unfavorable conditions as regards moisture and air.

I learned of the Rodine inhibitors in connection with my pickling work in the steel industry. They were quite generally used in that field by a number of different companies. My first work on oil production problems occurred after I became a fellow for the Gulf Production Corporation. Prior to my work as a fellow, which resulted in the report which is printed in the Williams Bros. record begin-

ning on page 587, the work I did on production problems was on corrosion of production equipment, mainly for the short period prior to the start of the investigation on "gyp" formation.

The Production Corrosion fellowship was concerned with corrosion of production equipment merely for the Gulf Production Company of Texas and the Gulf Pipe Line Company of Texas, whereas the Production fellowship at Mellon Institute was concerned with production problems of the whole Gulf Oil Corporation and all of its subsidiaries. Production Corrosion fellowship was definitely for the Gulf Production Company and Gulf Pipe Line Company, of Texas, Louisiana and Arkansas.

At the time I was working on this "gyp" problem and for several years prior thereto, the Gulf Companies owned production in lime fields, where the oil is produced from lime formations. Those fields were in Kansas, Oklahoma, Texas, specifically the Eldorado field in Kansas, the McElroy field in Texas, the several fields in the Panhandle district of Texas. The Gulf Companies have substantial production in those fields.

Prior to the time when I made my report on this "gyp" problem I had not had any actual field experience in connection with oil production. My work had been confined to laboratory work and field trips for observation. My first field trip was in the summer of 1927 to various fields all over Texas. The trip was a general trip intended to acquaint me with general methods and problems of oil well production. I think that is the best way to put it.

Q. In your direct testimony I understood you to say that in your opinion the use of inhibitors in hydrochloric acid would not affect the action of the acid on the scale. I will ask you what, if any, tests you made to determine that fact. A. Qualitative tests were made. These tests consisted in treating the scale with inhibited hydrochloric acid. When the tests were made on the scale, it had been removed from the pipe. I don't recall definitely whether I ever tested the effect of inhibited hydrochloric acid on oil well pipe from which the scale had not been removed

at the time of that investigation or not. They were done subsequently, however. I don't recall having made any at the time of my report, but I did make such tests subsequent to the date of the report.

With regard to my qualitative tests with inhibited acid on scale, it consisted merely of treating the scale with inhibited hydrochloric acid to determine qualitatively whether there was any appreciable difference in the amount of the scale dissolved or the rate of dissolution. As I recall, the test was probably placing the scale in the acid. I do not recall definitely having done anything else in that connection. I wouldn't say that I did not, though. That test was made on the sample of scale received in connection with the submission of the problem. That is the only sample of scale I had. I would have to look at the records as to having ever tested any scale that came from other wells or other locations, but I believe that some samples were submitted from Grand Bayou field.

There are a great many different chemical combinations in the scale in different locations, also in samples of scale deposited in engine jackets from water, depending upon the constituents of the water or the impurities in the water. If I received any scale from different locations, I undoubtedly tested them, when submitted to me, for a period of approximately two years from 1927. Any samples of the scale that were submitted to me during that period were tested. As I say again, I don't recall definitely whether we had other samples or not. The only tests that it would have been necessary to make were to determine the composition of the scale. I will have to consult the record to tell definitely whether I did any work along that line. My recollection isn't clear in regard to other samples from Glenpool or Grand Bayou.

Q. I believe you expressed the opinion that pressure would have no effect on the action of the inhibitor in hydrochloric acid, or did I misunderstand you? A. With regard to the action of acid on what?

Q. On lime formation. A. I believe the statement I

made was that it would not have a very appreciable effect as distinguished from absolutely no effect.

Q. And that opinion is expressed on the basis of your knowledge at the present time, I assume. A. Also my knowledge at that time.

Q. In other words, you say that would have been your opinion then? A. That is right. That answer applies only to the effect of the inhibitor itself, not to the effect of pressure on the action between hydrochloric acid and scale.

Q. And what effect would the pressure have on the action of the acid. A. It would slow it down. What I understand you are trying to distinguish between is the effect of inhibited and uninhibited acid as regards pressure.

I know who Mr. F. W. Karl is. At that time he was a corrosion engineer for the Gypsy Oil Company, and had been with them for a very short period. He was not one of the members of the corrosion fellowship. He was one of the field engineers. I knew him personally. I would say that he was very competent in his line of work and was when I first met him, I believe in about 1926.

I first met Mr. Henry McGraw either late in 1927 or early in 1928. At that time, he was vice-president of the Gypsy Oil Company. He was not a scientific man. He was a lawyer engaged in the oil production business. When I first met him, I considered him to be fairly competent as an executive. I discussed technical problems with him only in a very general way, not in any detail at all. I believe, considering the fact that he was a lawyer, he had an excellent grasp of the technical problems involved in the production of oil.

Mr. Leovy was vice-president of the Gulf Production Company located in Pittsburgh. Mr. R. L. Wright at that time was chief production engineer for the Gypsy Oil Company. He is a technically educated man. As far as I know he was a graduate engineer.

Mr. C. P. Dimit was superintendent of production for the Gypsy Oil Company. I am not sure at that time what Mr. M. E. Chapman's connection was with the Gulf Company. He was at one time an assistant to Dr. Knappen,

and later he was production engineer for the Gypsy Oil Compay. He was technically educated; I am not sure what his degree was, but I think it was in geology. That is merely my recollection of it. Mr. W. B. Wilson was chief geologist for the Gypsy Oil Company. He was technically educated. His degree was in geology. I know Mr. L. C. Case. I knew him in 1929. He was a chemist in the geological department of the Gypsy Oil Company. I do not have in my correspondence file a copy of a letter written by Mr. Case to Mr. Wilson on August 30, 1929. I know Mr. D. L. Traps. His title at the time of his connection with the Gulf Company was consulting engineer. He was technically educated in engineering. Frank J. Reed was a chemist employed in my division. Mr. S. G. Sanderson was at that time production superintendent for the Gypsy Oil Company. He would replace Mr. Dimit. He was not a technically educated man. Mr. W. L. Rushmore was the production engineer for the Gypsy Oil Company. Mr. H. H. Power was, I believe, at that time chief engineer for the Gypsy Oil Company. He may, however, have been consulting engineer at that time, I am not quite sure. He was technically educated. I believe Mr. Rushmore was technically educated, I am not certain about him.

I have seen several acid treatments made on wells of the Gulf Company, or its subsidiaries, by Dowell Inc. and by Halliburton Oil Well Cementing Company, for the purpose of increasing the production of the wells, but again it would be necessary for me to consult my records to make absolutely certain who made those treatments. I believe those treatments were made about 1931 and 1932.

I did not receive any samples of the producing formation in the Glen Pool during the time I was experimenting on the gyp problem and prior to the time when I made my report of July, 1928. I don't recall whether or not I knew at that time what the producing formation was in the Glen Pool, the geological name of it. I believe the producing formation in the Glen Pool is reactive to hydrochloric acid, but to what extent, I couldn't say. I have no direct knowledge on that subject. I made no tests on it.

REBUTTAL PROOFS

DR. CARL F. PRUTTON,

a witness called by plaintiff, was recalled, and testified further as follows:

DIRECT EXAMINATION

By Mr. Owen:

Q. Doctor, you heard the testimony given in this case regarding corrosion tests made by Dr. Bartell and by Mr. Douty and Mr. Hathorn. Will you consider and compare the results of those tests insofar as they are comparative, and in doing so, confine yourself to the tests with the Hathorn soft metal tanks. That is, I want you to consider those tests with reference to the effect on corrosiveness of hydrochloric acid on steel of the presence of small quantities of lead chloride, copper chloride and iron chloride in the acid. A. There have been described by Mr. Douty, Mr. Hathorn and Dr. Bartell and myself, a number of different types of tests for determining the corrosiveness of acid and the effect of dissolved metal chlorides, particularly the lead chloride and copper chloride upon that corrosiveness. There have also been tests described to show the effect of the lead plate in protecting the storage tank or truck tank in the so-called Menaul process. The one thing that can be gathered from all of these tests, although the tests all varied in metals used, in specimens, in the detailed method of cleaning, throughout all of them the results of tests made in which acid containing approximately 4 parts per million of copper and around 400 parts per million of lead, both in the form of chlorides, and about 400 parts per million of iron, the results are remarkably close from a comparative standpoint. The results that were reported by Dr. Bartell showed that those concentrations of metals which he had found in his analysis in the Halliburton truck samples gave

approximately 40% inhibition on one of his test methods, or 40% reduction in corrosiveness. Then he varied his test conditions to come closer to some of the conditions that we had used in our laboratory test and he got results up to around 60 to 65%—in that range.

Q. That was by agitation? A. By agitation and by using a little greater volume ratio to the area of the sample. Then the tests that were reported by Mr. Douty in his laboratory tests that he ran personally himself, indicated that the copper, iron and lead chlorides corresponding close to the compositions that the other men had tested, showed 50 to 60% inhibition, or reduction in corrosiveness. The single test that Mr. Hathorn reported in his large tank in which he used a type of steel that is comparative to the tubing and casing, the tank was made from a piece of casing, as shown in his last curve, showed 40 to 60% inhibition due to the dissolved metallic chlorides. His results on the hard steel tank were not conclusive but the ones on the soft steel tank show 40 to 60% inhibition. The results that I reported from our special condition laboratory tests, using a small section of well tubing, showed about 65% inhibition in the laboratory tests. And therefore, the figures that were reported by various men Dr. Bartell has covered a range of 40 to 65% approximately, Mr. Douty from 50 to 60%, the tests that I reported in the laboratory test alone, showed about 65% and the tests that Mr. Hathorn reported on this soft steel tank with the added metal chlorides present showed 40 to 60%. And I think that is quite a remarkable agreement in measuring the reduction in corrosiveness of acid under these widely different sets of conditions.

So that is the thing that can be compared out of all of these tests, is the effect of these added metallic chlorides, and the fact that the range covers a range of twenty-five per cent is not unexpected at all.

Q. Will you make a similar comparison with reference to the effect of the presence of lead chloride alone, in fifteen per cent hydrochloric acid? A. Well, the effect of lead chloride alone is not so clear cut in the various tests. I

reported several tests in which the inhibition ran somewhat over ten per cent in my laboratory test alone. Dr. Bartell reported approximately ten to fifteen per cent. The figures that Mr. Hathorn reported are confusing and the only one that could be used to show that is one curve which showed a considerable inhibition due to lead chloride. I believe if I could refer to the curve, why, you could see it.

But there is—I hesitate to draw too many conclusions from these curves. I think that from these curves you could draw any conclusion you wanted to, and the C. P. acid is up here, and the C. P. acid plus lead chloride alone is down here, and there is considerable reduction if you take the vertical distance between these curves, there is approximately fifty per cent, without calculating it closely.

I have indicated in my direct testimony that I believe the check determinations are within about ten per cent, and the different observers using different tests, of course, you could get further variations.

But there is a considerable variation between the C. P. acid and the C. P. acid plus lead. Then when he (Hathorn) added copper again, however, he spoiled the picture by showing it had no effect whatever, which is contrary to all four men's laboratory results. So the picture is not so clear.

Now, Mr. Douty ran lead chloride in laboratory tests, and in a fifteen hour test he showed 39 per cent reduction in corrosiveness due to the lead chloride, and in a 96 hour test he showed 38 per cent reduction in corrosiveness, so his figures are the highest of the group and would come closer to the figures indicated on Hathorn chart, Sheet No. 6, but I say I hesitate to draw any definite conclusions from these curves.

Q. Have there been any tests described during this trial other than your own that would give any measure of the effect of the Menaul electrical hook-up to the oil well tubing or casing? A. The only tests that have given any indication as to how the actual Menaul system would perform on the oil well tubing have been tests that I reported.

The other tests have confined themselves to large areas of lead in close proximity to steel surfaces and both surfaces covered by acid. And, therefore, I do not believe that the other men that reported tests can draw any conclusions from those tests as to what happens down in an oil well tubing system remote from the Halliburton or Menaul type truck tank.

Q. You heard Mr. Hathorn's description of the method used in cleaning the tanks between tests. I would like to have your comment on the effectiveness of that method of cleaning and its possible effect on the results of the succeeding tests? A. I hesitate considerably in discussing other people's work, and for that reason I have hesitated to draw too rigid conclusions from those curves. That is particularly true in the testing of corrosiveness of solutions. I have been engaged in testing the corrosiveness of various materials for fifteen or twenty years, and have supervised hundreds and thousands of tests, without doubt, in various types of products, and know the variability that can be expected, and the variability due to the surface condition of the metals and the formation of various types of films on the surface which affect results.

The running of inhibition tests by inexperienced people, or people who have not had experience in running those tests, is a very dangerous thing, and can lead to erroneous results. Not knowing exactly what experience Mr. Hathorn and his co-workers have had in running inhibition tests, I hesitate to draw any rigid conclusions as to the results; but the tremendous variation of these curves from which you can draw any conclusions whatsoever—any conclusion to be desired could be drawn from those curves—indicates to me that the work evidently was not controlled very accurately.

One of the things that to me—not knowing the details of the cleaning operation, but the immersion of a lead-coated steel tank into a sulphuric acid solution to clean off the surface, when it is known that lead is used for the handling of sulphuric acid because it will not dissolve, even

carrying the work—in electrochemical work, lead is used as an insoluble anode in sulphuric acid solutions—then in addition to that, to using a bath that is used for pickling commercial work, in which steel evidently with the oils and greases and dirt that get on to such steel objects, in the working and shaping of the steel, and many of those oils that are used in the work—many of those oils containing a considerable amount of sulphur, containing organic compounds which are well known inhibitors, and the fact that the condition of that tank was not known accurately, whether there were any dissolved metallic materials in the tank—all this would indicate to me that the cleaning might have been quite a major factor in determining the variability in the results.

Those are about the only comments that I could make upon the possible deviation and inaccuracies that have occurred.

The Court: Well, we have inaccuracies in all our experiments. How can I know that anybody got their container clean? A. We studied in this method that we employed for cleaning our surfaces, we took small pieces of the steel tubing and used this cleaning operation method and could take those samples after doing that, and get reproducible rates of solution and acid before and after solution containing lead and various other material. When we come back to the commercial acid we get the same result. The checking of the method of cleaning that we employed in our tests, Mr. Douty, Dr. Bartell, Mr. Douty and I in particular, were very similar in that we pickled all the samples in hydrochloric acid and then brushed off the material on the surface to remove any surface deposits to get down to fairly clean metal, and then started in. Now, the use of the anodic cleaning in sulfuric acid introduces a variable. I wouldn't want to say what effect that had even though the tank were free from impurities, no grease on the tank, no metals in the tank system proper.

We took the same piece of tubing, determined the rate of corrosion, took that tubing, cleaned it, got exactly the

same rate; then took the tubing, ran it in lead and copper chloride solutions, cleaned it again, put it in commercial acid, and got the same rate as before.

The Court: The second run? A. Yes. We gave it a cleaning after the lead treatment; after the lead chloride, copper chloride, we gave it our cleaning.

The Court: Then what did you do? A. Put it in commercial acid and got the same result as we had gotten in commercial acid before. That would indicate. I say the same—I don't mean exactly the same—I mean within the limits I have indicated corrosion tests should be run if you specify every single factor and carefully control. That is approximately 10%. I think I have stated that before. It is within about 10% of corrosiveness.

The Court: In what way does this dissolve or in what way does this metallic chloride, whether copper, lead or iron chloride that is in the acid protect the iron? What was the method for doing that? A. The only way I can see, and I have no experimental evidence that will back it up. Mr. Douty has shown when you connect a lead plate with a piece of steel you actually get some lead plated on there and a reduction in corrosion against that steel which is perfectly in agreement with my views. I wouldn't criticize that part of it. But when you only have lead chloride in solution then it is my belief that you get a very spotty coating of molecules or particles of lead not as complete as Douty reported on his case where the lead sheet was actually connected with the lead, but you get a very spotty coating, and that incomplete coating of lead and of copper, it is well known, for example, that when you put a piece of steel in your copper sulfate or copper salt solution, you get copper coating, red color copper. I believe that takes place to a small degree.

The Court: That is with the degree you get protection on it? A. Yes. Now, in the electrolytic method when the electrodes are close together, they get a fairly continuous sheet of lead.

The Court: In other words, whether it be with the

electrical connection that goes right across, deposits down, or whether it be in solution, or goes slowly across, all the protection the iron ever gets is by coating? A Is by the coating, and the effect that that coating has upon the actual corrosion mechanism. That coating itself is not a protection in itself, but in the corrosion of iron and steel hydrogen tends to be formed on the surface of the metal. We see that when we put a piece of iron into hydrochloric acid, and see the bubbles of hydrogen evolved. Those individual bubbles tend to hold that hydrogen on the surface and in that way insulate the surface from the acid and prevent the electro-chemical solution of the iron. In the case of a continuous lead coat, that is like putting a coat of paint or a sheet of rubber between the two. It protects, of course, by that method, but it is not a complete coating of copper or lead. I wouldn't believe that that would be possible. If it were, you could see a red color or color of copper when you use these very dilute copper solutions.

Mr. Owen: I show you Mr. Douty's notes, DX-299, and call your attention to sketches on the back of sheet B which I understand to represent the set-up for Mr. Douty's tests. I believe you are familiar with these notes, and I will ask you to examine those sketches and point out the course of the current in those.

The Court: Before you take that step up, how about the experiments performed in these tanks by the young man from whom these charts were drawn that are now on the trestle-board being more similar to the actual use of the storage tanks and the transportation tanks—or the transportation tanks, than any of the others? If I could only test those, that would be more similar than any of the other tests. A. In the truck tank, the Menaul truck tank?

The Court: Yes. More like the Menaul truck tank work than these others, or wouldn't it? I don't know. A. Well, the feeling that I have had and that I have expressed, I believe, in my testimony, is that in the work that we did we were not primarily interested in what protection the lead sheet gave that truck tank; that we were interested in

the part of the Menaul process which involves the protection of the well tubing and, therefore, we used that tubing method. Now, the question as to how much protection the lead sheet gave our tank and whether our tank was more comparable to the Halliburton tank than the ones that are shown here, is also a question that is in considerable question. The tanks shown here do not have the lead plate welded on the bottom.

The Court: I follow you.

The Witness (continuing): The question was with relation to Mr. Douty's tests in which he used the lead sheet touching the steel strip in his corrosion experiments. Of course, the arrangement of the lead sheet and the steel could hardly duplicate the conditions you have in a truck tank, and the ratio of the lead area to the steel area is considerably at variance with the actual ratio which Mr. Hathorn used and which we used, and the lead strip was scraped clean with steel wool, which is not done, as I understand it, in service, and which we did not do, and I do not believe the lead sheets in those tanks were scraped with steel wool, which would roughen the surface greatly. And then the lead sheet was bent around and made to contact in two separate places with the piece of steel.

I think that in this test that he describes that all precautions were taken to get that double contact with the lead sheet as shown in his picture on the back of page B where the steel strip is contacted both at the top and at the bottom of the lead sheet. The arrangement of the lead sheet in the beaker test that he ran was as shown in the middle figure on the top part of the back of page B, and shows his beaker in that position (indicating on blackboard) the lead sheet bent into a sort of a "U" and then around in this fashion (indicating), and then his steel strip in contact here and at the bottom with the steel contacting the lead in two places.

Now, that would insure that the distance from lead to steel was fairly close and in the truck tank there are portions of steel that are fairly well removed from the—that

is, as I understand, the bottom of the truck tank has a sheet of lead on it, and the sides of it extend up some considerable distance and the lead is fastened here, but the steel is not brought in quite such good contact.

The Court: I understand there is acid under the lead plate—isn't there? A. There is acid under and over, covering up to some considerable height, and in the tests here, the acid was over the top of the system.

I do not want to point out any great difference here, because I do not think for the purposes that we are discussing it here, the significance is great, but there were some slight differences between the tests and what actually occurred in the tank.

Q. I would like to have you comment further on the Hathorn tests and curves. A. The curves that have been obtained, if we take some of these curves, we find a looping up in this direction, and unless you knew that there was a discontinuity here (indicating), normally you would plot that, just drawing a line through this (indicating), sort of in that direction, and knowing the tremendous variations that occurred between individual tests, you would not try to draw any conclusions from the change in slope of that line, and particularly the change in slope of this line, compared with this other line, which shows such wide variation.

Now, you may say, well, they took samples immediately after disconnecting the lead, and it showed an increase in iron content, indicating that where the lead plate was disconnected, there are some points in here that show, when they took samples immediately thereafter, and that is perfectly true, that there was an increase in the rate of attack when that lead plate was disconnected.

I have indicated, and I think these tests indicate, that the lead plate does something in inhibiting by electrical means, the attack of the acid upon this, upon these particular hard steel tanks, and that this slope here is much less than the slope here (indicating).

But, if you take this slope here, when this was disconnected (indicating), the slope is just as flat as this lowest

one, with commercial acid. So if you take the average here, it would show that there is still inhibition in the acid (indicating)—

The Court: But the lead plate— A. (Interrupting): The lead plate does some good.

The Court: Was bringing about some action? A. Some action, but there is a continuing action, and it is difficult to say just how much, but this shows inhibition (indicating). We don't know whether this solution at this time was the composition of their truck samples that we obtained from the field, with the high copper content; possibly it wasn't although you can't tell, you can't tell a thing unless you knew the concentration of the metals in that solution, and if they carried on what actually occurred in the Halliburton truck tanks.

I am explaining on sheet 1 the results on the hard steel tank, which is steel supposedly used in the truck tanks. That follows through, I believe, on all the steel tanks. You get that flatter part there (indicating) but when you get over to the results on the soft steel tank, made from a piece of well casing similar to a well tubing, the picture changes completely. I want to show you those figures and curves. On sheet 4 the effect of the electrical protection is substantially zero. There may be some slight change in slope in the upper part of the curves, there may be some break here (indicating top of sheet) I can't detect it. Here is commercial acid, Tergitol, lead plate, test 4 (indicating); commercial acid and lead plate test 5 (indicating); commercial acid plus lead plate test 3 (indicating). All show no sudden jump here in iron concentration. But when you come down here to this one test (indicating) there are three tests with the lead plate that show no electrical effect.

The Court: This lead plate was connected? A. Up to this point (indicating) and then disconnected.

Mr. Owen: Where the dotted line starts.

The Court: Now, what is your explanation for that? A. My explanation is that this protection—this is a little

lower than the commercial acid—is substantially not due to electrical protection but due to the lead and copper dissolved in the lead plate. If there were electrical protection and a sudden jump here, great change in slope. You see he has tests 4 and 5, commercial acid and Tergitol, lead plate—

Mr. Owen: The three with lead plate are numbered 3, 4 and 5. 1, 2 and 3 on sheet 4. A. The one that shows electrical protection is curve for test 6, 3 tests showing electrical protection, and one showing not.

Mr. Owen: Test 6 contains Tergitol. A. That is on sheet 4, the soft steel tank. We go over to the next curve on soft steel tank. These are curves where we measured this change in slope. Now, there are many changes in slope on these curves, but if there is any electrical protection—you will recall we put a straight edge on this—there is a slight change in slope there. If there is any electrical protection it is a very minute amount. It doesn't show this coming across horizontally and branching out. The amount is very minute. That is true in tests 5, 6 and 7—3 tests with the lead plate. Now, they have still another lead plate, to make this picture complete, No. 3, which shows no inhibition and shows practically the same as commercial acid but they did not disconnect the lead sheet from the tank in the test and we cannot tell what happened up there. Now, here we have on a soft steel tank, 7 tests, and 6 of those you can see that the lead plate has practically no electrical inhibiting effect; one of them shows it has a very strong electrical inhibiting effect. And that argument is used to prove you cannot find out anything by a test. My conclusion is that the one test is wrong, the one that showed the marked variation resulting from the electrical connection.

The Court: Now, I am at a loss again. I thought you were talking just on the soft steel. A. Yes, sir, on the hard I frankly admit there is a distinct electrical protection.

The Court: Can you tell me why there would be on

hard steel and not on soft steel? A. No, I cannot. Some of these corrosion inhibition effects are things that are difficult to explain.

Mr. Owen: Well, Doctor, has anything been presented here by Mr. Douty or Mr. Hathorn that in any way changes the views you expressed in your direct examination? A. No, sir.

The Court: In all these tests, Doctor, I get it that you do think that all that has been found in the Halliburton tanks can in fairness, honesty and scientifically be explained as being made by the lead connected up with the iron? A. I think that it is quite reasonable to explain the protection of the tank by that lead plate. And I would admit any amount of protection ranging from zero up to close to 100% as being possible.

The Court: And you don't think that without reference to oral testimony at all that you had reached the conclusion there had been something else independently added in addition to what, from the lead connected with the iron? A. I just can't tell.

The Court: All right.

(Witness continuing): Because the amounts Dr. Bartell found in these field samples on the few tests that we ran in our tank, or simulated Menaul tank, we didn't get the high copper content, got a greater iron content, didn't have the same ratio of metals but the inhibition was about the same with a degree of the reduction of corrosiveness as was found in the samples duplicating Dr. Bartell's analysis of the field truck samples. But I can't explain exactly, and I don't believe just, without a great deal of evidence, that something has been deliberately dumped into the tank.

The Court: Out of all of them, the variations so wide, have you reached any conclusions as to what percentage of the protection comes from this direct protection while it is connected and from the chlorides that have been created and are still in the liquid? A. I don't believe that I can or any of the figures here could tell exactly what percentage that would be. As to the per cent in the truck tank,

as to what percentage is electrolytic protection and as to what percentage is chemical, I don't believe you can tell.

The Court: They start out from the lead, evidently, don't they? A. They start out from the lead.

The Court: Is there any difference between them when they leave the lead chemically or any other way? Is there anybody living that knows any difference between those that go across and form a plating and those that become tramps floating around there, like a bunch of hoboes? A. They are all the same.

The Court: They are just the same, and it is just mere accident which gets over there by coating and which are floating around. A. Just some of them get over there, and it is haphazard.

The Court: And when we stop and make our test we have just caught some of them on the way, as you might say? A. It is more than that.

The Court: If they kept on up to the top some of them would have got over, wouldn't they? A. It is not quite like running from a piece of lead over here to a piece of iron; the amount that actually goes over there and continues on is not a great deal; the amount that goes in the solution is a considerable quantity. I think I made some approximations on this tank we had that about half a pound of lead dissolved in each test.

The Court: It all goes— A. All goes into solution.

The Court: And nobody knows which molecule, and the molecule itself don't know which one is going to get over there? A. That is right, you couldn't tell. But, that acid—

The Court: How much is that true in ordinary plating, when you do plating does some of it generally stay in solution? A. Oh, yes, you have to keep a large reservoir of ions in solution; this is typical of plating, that is all it is.

The Court: And when you stop any plating you find some of the thing to be plated and— A. A larger amount in solution.

The Court: And in every case you put it in solution

first? A. Yes, and there is a great amount in solution compared to the amount plated out.

The Court: All right.

Mr. Owen: I think this is clear to the court, but I want to ask just one question on it, and that is to what do you attribute the protection which takes place in the pipe, or in the well tubing, after this acid which has been hauled about in one of these Menaul tanks leaves the tank and goes into the well tubing? A. I attribute it entirely to the inhibiting action of the lead chloride, copper chloride, that is dissolved in the acid, plus some little contributing effect of any oil that might be in the tubing.

Mr. Owen: That is clear to Your Honor?

The Court: Yes. Of course that stuff always does a little plating as long as there is any of it in solution? A. And it doesn't have to have another electrode to do plating.

The Court: I understand, and when they are both there they are both working at it? A Yes.

The Court: But all the connection does anyway is to put more of the chloride into solution and the more chloride you get in solution the better plating you have? A. And it helps out with its voltage, it has a voltage there that tends to give you a little more plating too.

Mr. Owen: And your opinion, as you expressed it in your previous testimony, is that there is no electrical protection afforded to the well tubing due to the connection of the tubing to the tank by the copper cable? A. That is my opinion from theoretical grounds, and from the result of the tests we ran.

The Court: How about this for a theory, does it hold or is it just a new one; that about all the connection does, it does two things, one is to keep putting more of the chloride into solution, it does that? A. Yes.

The Court: And putting more in and throwing them off it sort of creates a current across there and tends also in addition to increasing the percentage of the chloride, it creates a current that helps carry it over? A. That is the thing that I believe to be true. I said "voltage," you

say "current"; we mean substantially the same thing, an electrical effect, it both supplies the lead and copper in solution—

The Court: And while it is connected— A. It pushes it over there.

The Court: The current puts what is in solution across.

Mr. Owen: Now, you explained before that the theory of the Menaul patented process is that the current will follow the stream of acid down into the well and then jump across to the tubing and back to the tank? A. That is the understanding of the process in the tubing.

The Court: As I understand it, the plaintiff here uses arsenic?

Mr. Owen: We have used arsenic, Your Honor. We are not using it now.

The Court: If they use arsenic, they get the very kind of coating that you are talking about? A. That is right, here (indicating) but if they use the organic type, then they get a different type of coating, it is a different type of coating.

The Court: As far as you have used arsenic then, do you admit that you infringed the Gravell patent?

Mr. Owen: If that claim is valid—if that patent should be valid—

The Court (interrupting): But I am not talking about its validity.

Mr. Owen: Yes, that is right.

The Court: But as to the others, you claim that you do not.

Q. I would like to have you explain the methods of handling hydrochloric acid during manufacture, storage, shipment, and pumping, which are in common use and have been in common use for many years. A. Hydrochloric acid, or muriatic acid, is considered to be one of the most corrosive solutions that chemists and chemical engineers have to deal with, and the materials of construction that are used to construct the apparatus in which hydrochloric

acid solutions are handled have been merely for the storage of acid, let us take that first, wooden tanks, stoneware tanks, that is earthenware, brick-lined tanks, and rubber-lined tanks.

The Court: Did you leave out glass intentionally? A. Glass tanks we do not have, but we have glass-lined tanks that are also employed in some cases, that is with a special glass, vitrified glass lining in the metal, but large glass tanks are not available. Now, in the transporting—there is also another material that can be used, a material known as "Hovag," which is a phenyl formaldehyde or bakelite type of material that can be obtained in fairly good-sized tanks. Then for storage we use glass, for small storage like in carboys which are ten gallons or so, but I do not believe any glass containers are used above that size, for smaller amounts than that we usually use glass. That is for holding the acid. Then for transporting it, that is, conduit through which we can run the acid, we have glass tubing, such as Pyrex glass; we have rubber-lined steel pipe; we have ordinary rubber hose; we have Hovag piping, or Bakelite piping; we have hard rubber pipe, and those are the principal conduit materials that are used in transporting hydrochloric through a conduit.

Then, in the pumping of hydrochloric acid, the types of pumps that are usually used are, first, stoneware centrifugal pumps, and recently there have been glass centrifugal pumps come on the market. Rubber covered steel centrifugal pumps are used. And those types of conventional pumps are a conventional means of forcing acid through conduit.

There is also another type of pump that is hardly called a pump, the acid lift, in which you place acid in a container like a rubber-lined steel drum, heavy drum, and apply air pressure on top of the acid, and that forces the acid to whatever height you might want to force it, or through whatever conduit you might want to force it.

In the manufacture of hydrochloric acid, the materials that are used, the materials of construction that are used

in the plants that I have inspected—and I have inspected a great number and actually designed several plants in which hydrochloric acid was used—the hydrochloric acid is never allowed intentionally, in any case that I can remember, to come in contact with steel.

These various materials that I have described are used in the plant construction. There are other materials used also. For example, recently, there have been developed carbon tubes and heat-interchanges made of carbon impregnated with resins, and that material is resistant to hydrochloric acid and is being used to some extent.

The Court: That would go back to the— A. (Interposing): To the tubing. Under the conduits.

The Court: Conduits? A. But it is very seldom that they use that carbon tubing outside of a big jacket where they have a bundle of tubes, carbon tubes, which is used for heat interchange purposes.

The gases of hydrochloric acid, at high temperatures, are not nearly as corrosive as liquid, and there are parts of the hydrochloric acid manufacturing plant in which contact is made between the gases and some iron containing materials. For example, in one process, using the Mannheim furnace for the reaction of sodium chloride and sulphuric acid, which is one method of manufacture in steel, they actually use a cast-iron heavy bin in which this reaction is carried out, but the temperature is elevated and the material is not allowed to condense, and the rate of attack upon that iron is not as great as you would have if you allowed the vapors to condense and form a liquid at around ordinary temperatures or slightly above, to let the liquid react on the steel.

Now, there are recently—and this is particularly true in recent years, since this acid treating of oil well art has started, that people have started to employ in one or two processes only steel in contact with even dry hydrochloric acid, and there is one plant that is operating—I haven't seen it, but I have read descriptions—in Wyandotte or right outside Detroit some place—it is that Sharples Sol-

vent Company—in which they actually pass hydrochloric acid vapors, containing some moisture, through steel equipment that contains a large amount of chlorinated hydrocarbon that evidently protects the steel in some way from the corrosive attack.

The use of unprotected steel in chemical processes for the handling of muriatic acid, that is, the liquid solution, I cannot recall a single instance of that having occurred prior to 1930, and only this one instance—

The Court (interposing): What is that? A. Prior to 1930 I know of no single instance of the use of muriatic acid in contact with steel, and only this one instance, the Sharples Solvent, since that time. In most of the plants they avoid contact of steel with the muriatic acid.

The Court: Was this one in 1930 by putting an inhibitor in? A. No. They were chlorinating—this Sharples Solvent Company chlorinates pentane, and they get a mixture of chlorpentane in hydrochloric acid, and then, in the condensing system that they have, which condenses the vapors and separates the chlorpentane from the hydrochloric acid, they use steel equipment, and the explanation which they give—I haven't read the article recently, but as I recall it the explanation is that the oily chlorine compounds form a coating on the steel and inhibit what corrosive effect would occur.

The Court: When did you first hear of an inhibitor? A. When did I first hear of an inhibitor?

The Court: Yes. A. Quite a while ago. I can't recall.

The Court: Did you ever hear of the use of it? A. You mean use of it in a chemical plant?

The Court: Yes. A. I have never heard of the use of inhibited acid where they deliberately added an inhibitor.

The Court: For any purpose, now. A. No—well, now, of course—

The Court (interposing): When is the first time? A. The first time I heard of inhibitors of any kind?

The Court: Yes. A. Why, I learned about that when I was in college.

The Court: Yes. But when did you ever first hear of that being used in a business way; I mean not in a laboratory, but in a business, in a business way, to make any kind of use of an inhibitor. A. Well, that goes back, as I say, back into my college days.

The Court: What did they use it for? A. It is used as material to add to sulphuric acid pickling solution, so that the acid would not pit the steel but would dissolve off the rust. And that is the first instance that I can recall, and just when I heard of it, I can't recall now.

The Court: I was trying to carry the use on through the other uses. What other use did you ever know of an inhibited acid? A. That, as far as inhibited acid is concerned, I had not heard of any uses up until the time of the Grebe-Sanford patent. I was not aware of the work of the American Chemical Paint Company.

The Court: Or of this other patent? A. No. I was not aware of that.

The Court: There isn't any question but what this is an inhibited acid in the Gravell patent, is there? A. That is correct.

The Court: But you had not heard of that? A. I had not heard of that.

The Court: Or the use of it? A. Prior to 1930.

The Court: Never heard of storing acid in anything? A. Never heard of it.

The Court: So that it had evidently been going on for some time. A. Well, I don't know the exact time of the use. And it had not come to my attention. And one of the fundamental things that a chemical engineer has to know is the art of the corrosiveness of various materials under various conditions. In other words, the chemical engineer is supposed to translate laboratory results over into plant results, and he must know the art, all the different building materials and materials of construction and what they react to, and what is the common practice and knowl-

edge in the methods of handling corrosive materials. That is an essential part and a vital part of the knowledge of the chemical engineer.

It is the most fundamental part of all, I would say, to know just what materials you can use. And the general knowledge that I have, and I have kept abreast of the chemical engineering literature and with many chemical companies that are in this business.

I have been connected with at least three companies and possibly four that use hydrochloric acid, and several of them that make it and handle hydrochloric acid in their business, in a practical way and not in a laboratory way, and I have not heard of the use of inhibitor to store hydrochloric acid, by putting an inhibitor in hydrochloric acid that you could store it in steel equipment.

The Court: You are satisfied it could be done? A. I have testified that it can be done, it has been done since this Grebe patent has come out, when the Grebe patent came out—

The Court: Oh, it was done before the Grebe patent? A. I say, I didn't have any knowledge of that.

The Court: You didn't have any knowledge of that? A. I am testifying as to my own knowledge as a chemical engineer in the field of corrosive materials, that I did not—that I was not aware of that. But there are always things going on, to some degree, that of course one cannot keep in touch with all of them. I could not tell all of the different things that are going on in the whole field. But in conversations, and in my readings, I had not come across the idea that you could put an inhibitor into an acid and handle the acid safely in steel equipment, until this Grebe idea came out.

The Court: But Grebe had nothing to do with putting it in a tank and storing it? A. I know that, but when they started in on the Grebe process, they started to use steel tanks.

The Court: And that is the reason you found out about it, that you studied the subject then, when you were

employed by Dow at that time? If you had been employed sooner, you would have found out about it sooner? A. I don't think, Your Honor—

The Court (interrupting): Now, isn't that what fixes the date when you found out about it, was when you were employed by the Dow Company? A. Oh, no, I don't think so, I don't think it was.

The Court: Wasn't that the reason that you began to study it thoroughly at that time? A. No, I don't think so.

The Court: What has the Grebe patent got to do with finding out about storing it then? A. It has nothing to do with it. It hasn't anything to do with it.

The Court: That was the reason, though, that you found out about the storage at that time, isn't it; it was then that you began to study intensively that subject? A. No, I didn't start to study it intensively then.

The Court: Then what has Grebe got to do with finding out about storing this acid— A. (Interrupting): It has nothing to do with it.

The Court: But that was the first time you found out about it? A. That is exactly right, but my reason was that I saw them hauling out of the Dow plant steel trucks with hydrochloric acid in them, and that was a shock to me, and in discussions I found out that they were taking steel tanks and putting hydrochloric acid in them.

The Court: How do you suppose they found out that you could haul it in tanks? A. I don't know. That is something that is beyond me.

The Court: How long was that after the Gravell patent, that you saw them hauling it in steel tanks? A. I didn't see the Gravell patent.

The Court: The Gravell patent is dated July 31, 1928. How long after that was it before you saw them hauling it? A. It was around the—the first time that I was acquainted with the Grebe method was somewhere around within a year after the conception given here; it was in one of those summer periods that I saw and heard of it.

The Court: That would be about five years. A. I wasn't aware of the Gravell method. I never heard anybody else who referred to the Gravell method.

The Court: Wasn't that the Gravell method that you saw there? A. No, because they used a different inhibitor, as I understood it, they were using an organic inhibitor. I didn't know at the time anything about Gravell.

The Court: If they were using an acid inhibitor, then you saw the Gravell method for the first time five years after the patent, isn't that right? A. I don't believe the method of adding an organic material inhibitor follows Gravell.

The Court: Didn't they first put in arsenic over there at the Dow? A. I don't know whether—my recollection was that they used an organic inhibitor fairly soon, and it is difficult to tell when they used different inhibitors.

The Court: Which would be the best to use? A. What is that?

The Court: Which would be the best one to use, if there were not any patents in the world? A. I believe the best one to use would be the organic inhibitor.

The Court: For the whole thing, for everything in the world, too?

Mr. Lyon: Isn't arsenic a stronger inhibitor than the organic material? A. Well, I have seen hundreds of numbers of inhibitions and I just cannot remember.

Mr. Lyon: Well, the strongest combination is the one in the Gravell patent of the combination of arsenic in the organic material, isn't it?

CROSS EXAMINATION

By Mr. Lyon:

Q. According to the Gravell patent, the most powerful of the inhibitors is those, or are those that are provided by a combination of the organic type and of the metallic type. Is that not correct?

Mr. Owen: I object to that because this witness has

not undertaken to testify about the Gravell patent. I have not asked him about the Gravell patent. He has seen it, but he is not in a position to express an opinion as to what it covers.

The Court: Did you refer to any patent?

Mr. Lyon: I did not ask him what it covered. I said, "According to the Gravell patent" the strongest inhibitor would be that which was provided by a combination of an organic type and the metallic type inhibitor, and I am asking him if that is correct, if that combination is the strongest?

Mr. Owen: It would require him to examine the patent.

The Court: I will sustain the objection so far as it refers to that patent. As I understand it, Doctor, you have not prepared yourself on that? A. No.

The Court: But if you want to ask him—

Mr. Lyon: The fact?

The Court: I think that would fit in with what we have been talking about, if you want to examine him.

Mr. Lyon: Just drop out the "Gravell patent" and answer the question, as a matter of fact, if you can. A. The combination of the two would be better than one of them—that is, better than the organic type? Well, out of the organic type, you can get some very effective inhibitors; and out of the combined type you can get some very effective inhibitors; and just where the—whether one is above the other, or underneath the other, I have not got clear in my mind, but I don't think there would be a great deal of difference. If you were to take organic matter that was a very poor inhibitor alone, and would get it in contact with—mix it in with some metal, such as arsenic, you would probably get an increased effect over the arsenic. I am just bringing out in my mind some general ideas that I have accumulated. But if you take an inhibitor that is very good in its own right organically, then I am not sure that the arsenic would make it super-excellent above that.

Q. Well, arsenic is itself a very good inhibitor, is it

not? A. I believe that it is, under many conditions and many concentrations, quite good.

The Court: But it is, without any organic? A. Without anything; yes.

Mr. Lyon: And something has been said here to the effect that there is no perfect inhibitor, but if you would add one to five per cent of an arsenic compound you would produce, would you not, some reduction in corrosiveness by something above 97 per cent? A. I couldn't answer that question.

Q. You haven't made any tests on arsenic? A. I have seen figures with arsenic under many conditions and the variability is quite great under the conditions of the test.

Q. And you know that the plaintiff in this case advertises that its inhibitor is 99 per cent effective. Have you ever made any check to see whether that is true or not? A. I have seen some inhibitors that are that good.

Q. And some such as the plaintiff has used? A. Yes.

Q. And what kind of materials were those inhibitors? A. Oh, they probably were some of the organic type.

Q. Mercaptans? A. Probably.

Q. And in what per cent were they used? A. I don't recall that. The variation is quite considerable and there are a number of mercaptans they have used. It is difficult for me to give an exact answer. They have had at least ten or twenty different mercaptan products that have gone in in different amounts, different dilutions, with oil additions, small amounts, and so it is difficult for me to give any exact figures on it.

Q. You can't tell me to what extent the corrosion will be reduced if you employ from one to five per cent of arsenic acid? A. I would think it would be up around 95 per cent or so. That is just a wild guess without—it might vary from that by as much as three per cent either way, or four maybe, and that is on a small scale laboratory test, that is very questionable as to whether that exact figure applies in an oil well. I do not believe it does.

Q. And you are not prepared to tell us whether, if you

added to that arsenic oxide or arsenic acid some additional inhibitors of the organic type you would get a further reduction in corrosion? A. Well, I think in most cases—in some cases you would. But it is difficult for me to recall millions of compounds, as organic compounds, there are just millions of possibilities and practically every one of them is covered by Gravell or implied in Gravell, to give you a positive answer that the sum of them would—I think some of them probably reverse the action and lower it. The contact I have had with the work that has gone on is of the type of overlooking results and to just give a general picture of what is going on rather than to accumulate all of these specific facts.

Mr. Lyon: I am surprised, in view of counsel's statement a moment ago, and Your Honor's ruling, for the witness to now be volunteering as to what is in this Gravell patent and what is covered by it. He just made the statement of what the patent covers. A. I have heard the testimony. I have heard the things it covers read, and there is a multitude of things that I have read out of the patent, but I have not studied the specific compounds in the Gravell patent.

The Court: I don't think that is in conflict with his statement about it.

Mr. Lyon: Well, I don't have any more questions. I think the witness' summary of these other matters is fair from his standpoint. I think there is no use going over it again. He hasn't drawn any extreme or exact conclusions.

The Court: Well, I want to ask one more question, just to straighten it in my mind, but before I do that, Doctor, I want to assure you that lack of familiarity with some particular branch of a field as big and ramified as it is doesn't lessen my faith in the witness in the least degree or surprise me in the least degree. I certainly would not be able to tell you when our statutory laws, all of them, had been changed, for all I work at it all the while, and it is, I take it, just as big a field to work in as my field of the law. But I did want to be sure I understood your answer and that was whether

or not you hadn't used, known of an inhibitor to be used in connection with acids generally, is the way I understood it; that is correct; is it, until about the time of the Gravell patent? A. I had known of inhibitors, but most of that knowledge was an inhibitor in the pickling art with sulphuric acid, and I knew the action of inhibitors as a general class, but the thing of pumping acid down wells and handling it in steel equipment was new to me.

The Court: You weren't familiar, as I understood it, and I say it doesn't lessen my faith in your testimony at all, but I want to know, I understood, for instance, you didn't know about that Interstate Commerce regulation for shipment of sulphuric acid in steel containers? A. I knew in general that, but I didn't know specifically. I know in general what you can ship acids in, I don't know all the regulations, I know them in general.

The Court: I understood you to say that until the Gravell patent you didn't know that an inhibitor had been put in the stuff for the purpose of shipping it or storing it in any way until that time, except you did know of the use for pickling? A. I knew that, but I don't recall in 1930 that I even knew you could even ship sulphuric in drums.

The Court: In other words, your answer applied generally and not simply to hydrochloric? A. That is right.

STIPULATION RE EDWARD D. LUMAN TESTIMONY

It is stipulated by and between counsel for the respective parties that if Edward D. Luman were called by plaintiff and sworn as a witness in the above entitled cause, he would testify as follows:

That he is a resident of Dallas, in the County of Dallas, State of Texas, and that his address is care of The Atlantic Refining Company, Magnolia Building, Dallas, Texas, and that his education includes majoring in geology at the University of Kansas from 1914 to 1917 and at the University of Oklahoma during 1917 and 1918.

That he has been employed for approximately twenty-two (22) years by the Atlantic Oil Producing Company and the Atlantic Refining Company, and that his duties while with said companies from the time of his first employment up to the present were as follows: Employed by Atlantic Oil Producing Company (now The Atlantic Refining Company) as instrument man in March, 1919, for the purpose of operating an alidade. In May, 1919, he was promoted to the position of field geologist. From September, 1919, to August 1, 1920, he was field geologist in Oklahoma. August 1, 1920, to August 1, 1921, he was field geologist in Mexico for affiliated companies of The Atlantic Refining Company. August 1, 1921, to May, 1923, he was resident geologist in Okemah, Oklahoma. May, 1923, to February 1, 1924, he was field geologist in Venezuela for The Atlantic Refining Company. February 1, 1924, to February 1, 1926, he was paleontologist for Tulsa Division of the Atlantic Refining Company. February 1, 1926, to July 1, 1936, he was division geologist for the Tulsa Division, and from July 1, 1936, to December 31, 1940, he was chief geologist for the same company.

That at present his title is chief geologist for the Atlantic Refining Company, in charge of all geological, geophysical and scouting work of the Atlantic Refining Company in the states in which said company operates in the general southwestern part of the United States.

That at the time he went to work for the Atlantic Oil Producing Company in 1919, the business of said company was that of producing crude petroleum; that the Atlantic Oil Producing Company was a wholly owned subsidiary of the Atlantic Refining Company, and was absorbed by the parent company during the year 1936, and that the business of the Atlantic Refining Company from that date to the present has been that of producing and refining crude petroleum.

That at the present time the Atlantic Refining Company owns and operates oil wells in the States of Kansas, Oklahoma, New Mexico, Texas, Louisiana and Arkansas; that in all of those states said company owns or operates oil wells that are producing oil from limestone formations, and that such wells are located in the following identified states, oil pools, and counties and have been producing oil from the limestone formations recited since about the dates given, all as herein below indicated, and that these statements are based on the records of the Atlantic Refining Company and the Atlantic Oil Producing Company:

(Here follows a list of pools, formations and Atlantic Companies' operations substantially the same as that printed in connection the Blum stipulation, infra, pp. 1162 to 1165.)

That he is familiar with the practice of "Acidizing" or "Acid Treating" oil wells to increase their production; that he first became familiar with such practice during the year 1933; that the Atlantic Refining Company and the Atlantic Oil Producing Company have had many of their wells acidized; that this practice was begun in the year 1933 and that the Atlantic Refining Company has its acidizing work done by acidizing service outfits.

That among the first wells which the Atlantic Oil Producing Company had acidized were the following: Grimes No. 1, Hobbs Pool, New Mexico, in April, 1933, by Dowell, Inc.; Lido-Waggoner No. 1, Vernon Pool, Wilbarger Co., Texas, in August, 1933, by Dowell, Inc.; Barrow No. 1, Shipley Pool, Ward Co., Texas, in October, 1933, by Dowell,

Inc.; and Annie Jones No. 7, Bowledge Pool, Seminole Co., Oklahoma, in May, 1933, by Dowell, Inc.

That the Atlantic Oil Producing Company and the Atlantic Refining Company have had between 300 and 350 of their wells acidized, of which number about 200 have been acidized by Dowell, Incorporated.

STIPULATION RE HORACE M. STAGGS TESTIMONY

It is stipulated by and between counsel for the respective parties that if Horace M. Staggs were called by plaintiff and sworn as a witness in the above-entitled cause, he would testify as follows:

That he is a resident of Dallas, in the County of Dallas, State of Texas, and that his address is care of the Atlantic Refining Company, Magnolia Building, Dallas, Texas.

That his education and experience include Bachelor of Science degree in Mechanical Engineering from the University of Kansas in 1918; a course in the United States Bureau of Mines School, Carnegie Tech., Pittsburgh, Pennsylvania; assistant engineer of tests in the United States Bureau of Mines and Army Ordnance, and advanced training in metallurgy and metallography.

That he has been employed for approximately twenty-two years by the Atlantic Oil Producing Company and the Atlantic Refining Company, and that his duties while with said companies have been as follows: Employed by Atlantic Producing Company (now The Atlantic Refining

Company) in April of 1919 for surveying work (approximately one year); production superintendent, Kansas (approximately one year); superintendent of pipe lines, Haynesville, Louisiana (approximately one year); chief engineer, Atlantic Pipe Company (1922-1927); planning engineer for the Atlantic Producing Company (approximately one year); consulting engineer for the Pipe Line Company (approximately nine months); chief petroleum engineer for The Atlantic Refining Company from March, 1929, to 1936; general supervisor of engineering—Operating Department, The Atlantic Refining Company from 1936 on. That at present his title is general superintendent, and that he is in charge of all drilling, operating and engineering work of the Engineering-Operating Department of the Atlantic Refining Company.

That at the time he went to work for the Atlantic Oil Producing Company in 1919 the business of said company was that of producing crude petroleum; that the Atlantic Oil Producing Company was a wholly owned subsidiary of the Atlantic Refining Company, and was absorbed by the parent company during the year 1936, and that the business of the Atlantic Refining Company from that date to the present has been that of producing and refining crude petroleum.

That prior to 1916 neither the Atlantic Oil Producing Company nor the Atlantic Refining Company owned or operated any oil wells, and that this statement is based on the records of the said two companies.

That at the present time Atlantic Refining Company owns and operates oil wells in the States of Kansas, Oklahoma, New Mexico, Texas, Louisiana and Arkansas, and that in all of these states the Atlantic Refining Company owns or operates oil wells that are producing oil from a limestone formation, and that such wells are located in the following identified states, oil pools and counties and have been producing oil from the limestone formations recited since about the dates given, all as herein below indicated, and that these statements are based on the records of the

Atlantic Refining Company and the Atlantic Oil Producing Company:

(Here follows a list of pools, formations and Atlantic Companies' operations substantially the same as that printed in connection the Blum stipulation, infra, pp. 1162 to 1165.)

That he is familiar with the practice of "Acidizing" or "Acid Treating" of oil wells to increase their production; that he first became familiar with such practice during the year 1933, that The Atlantic Refining Company has a large percentage of its oil wells producing from limestone formations acidized or acid treated, which practice was begun in April, 1933, and that the Atlantic Refining Company does no acidizing of wells on its own account, but has the acidizing work done by acidizing service outfits.

That the first wells which the Atlantic Oil Producing Company caused to be acidized were acidized by Dowell, Incorporated, among which were the wells identified below, which were acidized on the dates indicated and that this statement is based on the records of the Atlantic Refining Company and the Atlantic Oil Producing Company: Grimes No. 1, Hobbs Pool, Lea County, New Mexico, in April, 1933, by Dowell, Inc.; Lido-Waggoner No. 1, Vernon Pool, Wilbarger County, Texas, in August, 1933, by Dowell, Inc., and Barrow No. 1, Shipley Pool, Ward County, Texas, in October, 1933, by Dowell, Inc.

That the Atlantic Oil Producing Company and the Atlantic Refining Company have had about three hundred and forty of their wells acidized, and that of that number about two hundred of them have been acidized by Dowell, Incorporated.

STIPULATION RE EDWARD H. BLUM TESTIMONY

It is stipulated by and between counsel for the respective parties that if Edward H. Blum were called by plaintiff and sworn as a witness in the above entitled cause, he would testify as follows:

That he is a resident of Dallas, in the County of Dallas, State of Texas, and that his address is care of the Atlantic Refining Company, Magnolia Building, Dallas, Texas.

That his formal education consists of the following: graduate of Central High School, Philadelphia, Pennsylvania, and four years engineering studies at Temple University, Philadelphia, Pennsylvania.

That he has been employed for approximately the last thirty-five (35) years by the Atlantic Oil Producing Company and the Atlantic Refining Company, and that his more important positions while with said companies from the time of his first employment up to the present are as follows: Chief draftsman of Engineering Division of the Atlantic Refining Company for a number of years, made general manager of Atlantic Oil Producing Company in about 1918 and later also made vice-president and general manager of the Atlantic Oil Producing Company, subsequently became general manager then also vice-president of Atlantic Refining Company.

That to the best of his knowledge and belief the Atlantic Oil Producing Company was incorporated in about 1916, and that John W. Van Dyke, personally known by him, was the president of that company from about 1916 to 1936, and served as chairman of the Board of Directors of the Atlantic Refining Company from about 1927 to the time of his death in 1939.

That he was employed by the Atlantic Oil Producing Company from about 1916 to September 30, 1936, at which time said company was taken over by the Atlantic Refining Company; that from about 1918 to September 30, 1936, he was general manager of the Atlantic Oil Producing Com-

pany, and from about 1930 to 1936 he was general manager and vice-president of the Atlantic Oil Producing Company, and that from September 30, 1936, to the present time he has been a vice-president of the Atlantic Refining Company in charge of the domestic crude oil production of said company; that the business of said Atlantic Oil Producing Company was the production of crude oil and the business of the Atlantic Refining Company since his connection with it has been the production and refining of crude oil, and that said companies have operated in the following states and produced crude oil from the following pools therein beginning at about the dates indicated:

ARKANSAS

County	Pool	Formation	Date Atlantic First Operation
Columbia	Magnolia	Smackover	May, 1938
"	Dorcheat	"	August, 1939
Lafayette	McKamie	"	March, 1940

KANSAS

County	Pool	Formation	Date Atlantic First Operation
Rice, Ellsworth and Barton	Bloomer	Arbuckle	June, 1936
Rice	Brandenstein	K. C. Lansing	November, 1933
McPherson, Reno and Harvey	Burton	Arbuckle-Hunton-Chat.	June, 1933
Rice	Doran	Arbuckle	October, 1936
Stafford	Gates	Arbuckle	August, 1933
Barton	Hiss	K. C. Lansing	December, 1936
Pratt	Iuka	Simpson-Dolomite	October, 1937
Ellsworth	Lorraine	Arbuckle and K. C. Lansing	December, 1939
Rice	Lyons	Arbuckle and Simpson	August, 1936

Stafford	McNaughten	Arbuckle	April, 1937
Stafford	Rattlesnake	K. C. Lansing	October, 1938
Rice	Raymond	Arbuckle	August, 1936
Stafford	Richardson	Arbuckle	August, 1936
Ellsworth	Stoltenberg	Arbuckle	March, 1940
Ellis	Ubert	"	September, 1938
Rooks	Westhusin	K. C. Lansing	October, 1937
Finney	Nunn	Mississippi Lime	June, 1938
Scott	Shallow-Water	" "	January, 1935
Marion	Urshell	Galena (Viola)	September, 1920
Butler	Sensabough	Arbuckle	October, 1929

LOUISIANA

County	Pool	Formation	Date Atlantic First Operation
Claiborne & Lincoln	Lisbon	Petit	June, 1937

NEW MEXICO

County	Pool	Formation	Date Atlantic First Operation
Lea	Eunice	Permian	April, 1933
Lea	Hobbs	Permian	September, 1930
Lea	Lynn	Permian	January, 1938
Lea	Mattix	Permian	June, 1938
Lea	Penrose	Permian	January, 1938
Lea	Monument	Permian	November, 1936

OKLAHOMA

County	Pool	Formation	Date Atlantic First Operation
Okfuskee	Deaner	Waponucka Lime	1920
Pottawatomie	Avoca	Viola-Sandy Dolomite-Wilcox	August, 1928
Pottawatomie	Earlsboro	Hunton	February, 1928

Seminole	No. Earlsboro	Hunton-Wilcox	March, 1934
Seminole	W. Little River	Calvin & Wilcox	December, 1938
Stephens	Palacine	Pennsylvania Sand	March, 1930
Seminole	Wofford	Wilcox	April, 1935
Creek	Tuskegee	Meissner Sand	September, 1930
Seminole	Traugh	Simpson Dolomite & Wilcox	October, 1937
Seminole	Bowlegs	Wilcox & Hunton	May, 1927
Pottawatomie	St. Louis	Hunton & Simpson	September, 1927
Seminole	Seminole	Wilcox	February, 1927
Pottawatomie	No. E. Shawnee	Wilcox	August, 1937
Stephens & Carter	Sholem-Alechem	Pennsylvania Sands	January, 1927
Osage	Atlantic	Miss. & Arbuckle	April, 1922
Creek	Donnelly	Meissner & Wilcox	June, 1926
Creek	Mercer	Wilcox	February, 1924

TEXAS

County	Pool	Formation	Date Atlantic First Operation
Andrews	W. Andrews	Blaine	June, 1940
Crane	Church and Fields	Blaine	1927
Ector	No. Cowden	Blaine	1934
Ector	So. Cowden	Blaine	1934
Cochran Hockley & Terry	Slaughter	Clear Fox	November, 1939
Ector	Foster	Blaine	April 1, 1937
Ector	Goldsmith	Blaine	July 1, 1934
Winkler	Henderson	White Horse	May, 1936
Winkler	Hendricks	White Horse	June, 1928
Ector	Johnson	Blaine	February, 1939
Crane & Ector	Jordon	Blaine	March, 1938
Winkler	Leck	White Horse	August, 1930

Ward	Magnolia; Sealy Co.	White Horse	May, 1940
Crane & Upton	McCamey	Blaine	December, 1926
Gaines	Seminole	Blaine	January, 1939
Ward	Shipley	White Horse	March, 1929
Ward	No. Ward	White Horse	December, 1936
Ward	So. Ward	White Horse	November, 1929
Winkler	Kermit	White Horse	December, 1928
Willbarger	Vernon	Pennsylvania Sand	August, 1925

That all of the oil pools above listed produce crude oil from a limestone or calcareous formation.

That he is generally familiar with the method of treating oil wells producing from a limestone or calcareous formation with hydrochloric acid to increase the crude oil production of the wells, and that he first learned of or became familiar with such practice using raw hydrochloric acid during the period from 1910 to 1915, and that he first learned or became familiar with such practice using inhibited hydrochloric acid in 1932 or 1933.

That the Atlantic Oil Producing Company existed from 1916 to 1936 as a wholly owned subsidiary of the Atlantic Refining Company, carried on the crude oil producing business of said latter named company in the United States, produced crude oil from the various states and pools therein as above stated and did not have any of the oil wells it operated between the years 1916 and 1933 treated with hydrochloric or any other kind of acid with the object of increasing their production of oil; that the Atlantic Oil Producing Company first employed the practice of treating oil wells with acid to increase the production thereof in the year 1933 by employing Dowell, Incorporated, to acid treat with inhibited hydrochloric acid, among others, the following identified wells:

W. D. Grimes No. 1, Hobbs pool, New Mexico, in April, 1933.

Lido-Waggoner No. 1, Vernon pool, Wilbarger County, Texas, in August, 1933.

Barrow No. 1, Shipley pool, Ward County, Texas, in October, 1933.

EDGAR LEE,

a witness called by plaintiff, testified as follows:

DIRECT EXAMINATION

I live in Midland, Michigan, and have lived there all my life. I have been in the oil business and have drilled some wells. I cannot state the exact month, but in the summer of 1932 I started in the acidizing business and continued for perhaps a year. In this business I was associated with Mr. Dougherty and Mr. Fred Markey of Mt. Pleasant, Michigan. My association with these gentlemen was at first in the form of a partnership, and later we incorporated under the name of The Oil Makers. I think we incorporated in 1932, I just cannot remember. I was associated with Mr. Dougherty and Mr. Markey either as partners or as a corporation known as The Oil Makers for about a year and a half, perhaps, covering a period in 1932 and 1933. We were operating in Michigan and some in Texas and Oklahoma. We operated in the Greendale field of Mt. Pleasant, Michigan, and we also treated some wells in Muskegon, Michigan.

We were engaged in the business of putting acid into oil wells to try to increase the flow of oil by dissolving the limestone. We used hydrochloric acid. The first acid we used came from the Pennsylvania Salt Manufacturing Company at Wyandotte, Michigan. We first started to get the acid in a steel container, but the acid manufacturer would not supply the acid to us in that type of container on account of the fact that the acid was raw acid and they advised us to get wooden containers made and we did this. Mr. Parks, sales manager of the Pennsylvania Salt Manufacturing Company, said the raw acid would eat the steel tanks and he would not load the acid for us in those containers, so we had to have some wooden tanks made. We had a good steel tank which we sent to the Pennsylvania

Salt Manufacturing Company at Wyandotte, Michigan, and Mr. Parks, the manager, said they would not put the acid in the steel tank because he thought it would eat it out before we got the acid back to Midland. We had several wooden tanks made to haul the acid and used wooden tanks after that. These tanks were made for us by the Kalamazoo Tank & Silo Company at Kalamazoo, Michigan.

I have examined two invoices from the Kalamazoo Tank & Silo Company of Kalamazoo, Michigan, being orders No. 6318 and No. 6346, dated July 23, 1932, and August 11, 1932, respectively; and I recall that that is where we had these wooden tanks made, and these must be the dates on which the tanks were made. I had charge of buying these wooden tanks for this partnership or comapny. I went to the Kalamazoo Tank & Silo Company personally to order these tanks.

After I bought the wooden tanks I then went to the Pennsylvania Salt Manufacturing Company and bought acid, and put the acid in the wooden tanks and took it to Midland, Michigan, where I diluted the acid with water and treated wells with it. I and other of my associates had already heard of this business or method of using acid in oil wells. Mr. Sprenger, who was associated with us, had already treated some oil wells with acid, and also I think the Pure Oil Company had acidized some wells. We took the acid and put it into the wells, I think the first well we treated we didn't have any pumps. I think Mr. Sprenger syphoned the acid into the well. These wells were located in the Greendale field of Michigan and were owned by the McClanahan Oil & Gas Company. We were offering this acid treating service to the oil companies. We treated oil wells with acid for the McClanahan Oil & Gas Company, the G-Lee-P Company, the Gordon Oil Company, and then we treated some wells in Muskegon, Michigan. At this particular time my duties were that of treating wells with acid and trucking the acid from the Pennsylvania Salt Manufacturing Company at Wyandotte, Michigan, to the

oil fields in Michigan. Mr. Sprenger did most of the acid treating and I did most of the trucking of the acid.

When I called at the Pennsylvania Salt Manufacturing Company to purchase acid I just asked for acid. Mr. Parks, of the Pennsylvania Salt Manufacturing Company, telephoned us and cautioned us about getting the acid in a steel tank. This conversation was on the telephone. I was in Midland. Then I went down there to get the acid. Mr. Parks, the sales manager, said he would not load the acid for us into our steel tanks. I knew this because he called me and told me this over the telephone. Then I got the wooden tanks. When I bought the acid from the Pennsylvania Salt Manufacturing Company I just asked for acid, I guess. Mr. Dougherty and I went down to the Pennsylvania Salt Manufacturing Company to make arrangements to see about getting the acid. I do not remember the name of the gentlemen that we saw. We were supposed to get hydrochloric acid, because that was the acid they were supposed to use to treat the wells. We asked for hydrochloric acid because that is what we wanted to treat the wells with.

As a result of our treating wells in Michigan with hydrochloric acid, the prodution of the wells was increased. Some of the wells were increased a lot and some of the wells not increased so much. I know this because the operators gauged the tanks and because I was at some of the tanks when they were gauged.

I have made reference to the G-Lee-P Company. My name is Edgar Lee, and I have an interest in this oil company to the extent that I own some of its stock. This is an oil producing company. I own about $2,000 worth of stock in this company. The company has its wells in the Greendale field of Michigan. The Oil Maker Company acidized some wells for the G-Lee-P Company. I do not remember the names of these wells. I think, as a result of acid treating these wells, the production was increased, but I was not there when the gauging was done and I do not recall the exact amounts of increase. I would not care to state the exact increase. Mr. Walter Sprenger worked for the

G-Lee-P Oil Company and looked after the oil lease of this company on which the wells were treated by the Oil Makers Company.

We treated a well for the McClanahan Oil & Gas Company with acid wherein some damage was done to the pipe. I know this because I remember seeing the pipe afterwards and the pipe was pitted. By pitted I mean that the pipe looked as if little specks on it had been eaten away. This was the well tubing through which the acid had been introduced into the well. I did not put the acid into this well through the tubing, but I was there when it was done. I was not present when the tubing was taken out, but I saw the tubing afterward.

The Court: You don't know whether some of these fellows that were selling inhibited acid were there talking to him and telling him what a dangerous thing he was doing to use acid without an inhibitor? A. I presume some of the people were, yes, but that I couldn't say.

The Court: Were they around there selling the other kind of acid? A. You mean selling inhibited acid?

The Court: Yes: A. The Dow Company was selling their acid.

The Court: You have seen lots of pipes used long enough that would get rusted and pitted and everything else, don't they anywhere? These pipes don't last forever? A. No.

The Court: Do you know how old that pipe was? A. No, I don't.

The Court: You don't know what pitted it then? A. All I know is what he claimed, the acid did it, Your Honor.

Mr. Conner: Do you think it was right at that time that they were around there selling the inhibited acid? A. Yes, they all were selling it.

Q. And all those fellows selling inhibited acid were claiming that if you did not have inhibited acid, you would get your pipes eaten up? A. I presume they were, yes.

The Court: Those old pipes, after they have been used down there, acid or no acid, they are pitted up, aren't they, in time? A. I presume they are.

The Court: Haven't you seen many of them, being in that business? A. I am not in that business so much.

The Court: Can you tell a pipe that is pitted, from ordinary rust and wear of that kind, pitted by acid? A. No, I don't believe I could.

Mr. Conner: Now, Mr. Lee, as a member of this partnership, or of this Oil Maker Company, which was incorporated, did any complaints come to you, or to your company, that you learned about, as a member of that partnership, or as a member of that corporation, which complaints had to do with corrosion, or damage to the tubing, or other parts of a well, as a result of your company treating those wells? A. McClanahan, G-Lee-P, and I think the Gordon Oil Company, and I believe there was somebody in Muskegon.

Q. Did you ever make any settlement on such complaints? A. Well, I think that we paid for some tubing in some place, and then I think the way—

The Court (interposing): I think you had better tell the name of that place, and the time, and something about it, so that it can be verified. You use the words "I think." A. Well, Your Honor, I don't remember that, Your Honor.

Mr. Conner: I have a witness here who can tell all about that, and I will show the names of the companies, but I am now trying to get a complete picture of this, to show that you cannot use raw acid in Michigan wells.

Mr. Lyon: Do I understand that you do not rely on this witness, and—

Mr. Conner (interrupting): I am relying upon everything he says. He is a member of the partnership, and he knows all about this, and he knows that complaints came in there, as he has stated.

The Court: Well, he has not named but one, well, that isn't by name. There is only one that he said came to him.

Mr. Conner: Did you see the tubing, or any tubing, or any part of the well equipment in the G-Lee-P Company's wells? A. No, I did not.

Q. So that you do not know the extent of their corrosion? A. No.

Q. You do know, however, from talking with your associates, that there were complaints to a certain extent, but to what extent you don't know, with respect to corrosion troubles? A. Yes.

Mr. Lyon: I object to that. We are after actual knowledge, and not anything as to any legal partnership, or as to what may be imputed to a partner, or anything like that.

The Court: I will let it stand, but I will agree with you as to the evidentiary weight of it.

I cannot state for how long a period of time we purchased acid from the Pennsylvania Salt Manufacturing Company. We did not purchase all of the acid that we used in treating wells from this company. At the last we bought our acid from the Grasselli Chemical Company of Cleveland, Ohio. The Grasselli Company claimed that they had an inhibitor in their acid that would do away with the trouble that we had been having, and that was the reason we changed our source of supply for acid.

I have previously seen the letter on the letterhead of The Dow Chemical Company, dated September 23, 1932, and addressed to The Oil Makers, Inc., Mt. Pleasant, Michigan, and signed Willard H. Dow.

At this point PX-197 and PX-198, the two invoices from the Kalamazoo Tank & Silo Company, No. 6318, dated July 23, 1932, and No. 6346, dated August 11, 1932, were offered and received in evidence. Also offered and received in evidence was PX-199, being the letter dated September 23, 1932, on a letterhead of The Dow Chemical Company, and addressed to The Oil Makers, Inc., Mt. Pleasant, Michigan, and signed by Willard H. Dow.

The witness thereupon read the letter from Willard H. Dow (PX-199) to The Oil Makers Company, as follows:

"Oil Makers, Incorporated,
Mount Pleasant, Michigan.

September 23, 1932.

Gentlemen:

"Attention: Mr. Charles Dougherty.

"We are advised that you are infringing United States Patent 1,877,504 issued to this Company and entitled 'Treatment of Deep Wells.' For your information, a copy of that patent is enclosed herewith.

"You are respectfully requested to immediately discontinue the use of acid in any manner which will infringe the rights secured to us by the aforesaid patent. We will appreciate an early acknowledgment from you and trust that it will be unnecessary for us to take any legal steps to enforce our rights under this patent.

"Very truly yours,
The Dow Chemical Company
Willard H. Dow
President and General Manager."

(Here PX-197, 198 and 199 were offered and admitted.)

The Court: You didn't read the date. A. Beg pardon. September 23rd, 1932.

The Court: September 23rd. What is the date of those invoices?

Mr. Conner: The date of the first invoice is July 23, 1932, and that is PX-197.

The Court: Yes. And the next one?

Mr. Conner: Plaintiff's Exhibit 198 is dated August 11, 1932.

The Court: What is the date of the purchase from Grasselli at Cleveland? A. I can't give the exact date.

The Court: That is the important date.

Mr. Conner: That is the important date. I will show that later. I will show it at a later time.

The Court: What is it?

Mr. Conner: Just to give you a resume of what I hope to show, I will show this company started acidizing wells

some time in June of 1932, and it did a little bit of business in that month, and continued through July and all of August, and during that time bought all of their acid from the Pennsylvania Salt Company at Wyandotte, Michigan. Now, that was raw acid, I hope to prove. Then after August 31st they then started buying acid from the Grasselli Company beginning in September of 1932.

The Court: What time in September?

Mr. Conner: That will depend on the invoices I have here, as well as the checks for payments. The first check I have to Grasselli is dated September 19th, 1932.

The Court: Well, now, Mr. Dow—I am just getting it. Mr. Dow is a mighty quick acting chap, but he never got that invoice of September—what it it, September 19th? He never got around through his law department and everywhere else to notify them of that infringement. He is notifying them and there are some things you indicate you know you had a good patent on acidizing wells. Did they say anything to you about it or have any talk with him about this, about what you were doing? A. Just the letter is all.

The Court: What kind of acid were you using before that? Here you get a letter September 23, 1932, telling you you are infringing the patent. What kind of acid had you been using? A. We had been using the raw acid first, and the acid—

The Court (interposing): Up to that time, I am talking about? A. I don't know whether we were using inhibited acid then or not. I don't remember what the date on that was or when we got our first acid. The invoices would show.

The Court: Well, what did you understand you had been ordered to stop doing? A. Not to be treating wells.

The Court: At all? A. Yes.

The Court: Well, that is the way I would understand it. It doesn't say anything about inhibition in your letter.

Mr. Conner: Oh, if Your Honor please, this letter, to my recollection, states that it is notice of infringement,

mentioning United States Patent 1,877,504, which is the very patent here in suit.

The Court: I know it, but then they evidently are getting after them if they know they are acidizing wells to notify them. I don't think that amounts to anything.

Mr. Conner: That is as it may be.

The Court: Because the plain conclusion to be drawn from this is that they have been using acid that was not inhibited at all, and bang, they notify them to quit. Quit what? Quit acidizing wells.

Mr. Conner: Well, if Your Honor will keep in mind the month of August and July of 1932, I think I will be able to show you which acids they were using in August and which acids they were using in September, I mean, and from whence those acids came and just what they were.

The Court: All right.

At this point PX-200, a letter dated October 14, 1932, addressed to the Oil Makers Company, Midland, Michigan, attention Edgar S. Lee, and signed F. C. Zebornick, of the Grasselli Chemical Company was offered and received in evidence.

The Witness: I have seen this letter before which reads as follows:

October 14, 1932.

"Oil Maker Company,
Midland, Michigan
"Gentlemen:

"Attention: Mr. Edgar S. Lee

"The writer happened to be in touch with our Cleveland office today and was informed that our legal department is forwarding you a letter today, which will give you necessary protection against infringement of Dow's patent in using or selling Duclean 2-A for treatment of oil wells. We trust this document will be found satisfactory and that you will be able to go ahead with any and all plans you have in mind for the promotion of our Duclean 2-A.

"We understand from our Mr. Fisk, who interviewed you the other day, that you propose making another visit

to the Cleveland office with the idea of ironing out matters pertaining to other fields.

"We certainly appreciate the attention you are giving this item and assure you we will be glad to lend you whatever co-operation will be required to enable you to get your share of business.

"Thanking you, we remain,

"Yours very truly,
The Grasselli Chemical Co.
F. C. Zebornick,
Branch Manager."

At this point PX-201, a letter dated November 21, 1932, from the Grasselli Chemical Company of Cleveland, Ohio, addressed to Edgar S. Lee, of the Oil Makers Company, Midland, Michigan, and signed by Grasselli Chemical Company, H. M. Rosenerans, was offered and received in evidence.

The Witness: I have seen this letter before, which reads as follows:

November 21, 1932.

"Mr. Edgar S. Lee
Oil Maker Company,
Midland, Michigan
"Dear Sir:

"I have your letters of October 26th and October 31st, the former in reference to the G-Lee-P Company and the latter referring to the Gordon Oil Company. In our guarantee to you covering protection against the Dow patent, you will note that we have not only guaranteed protection to you, but also to any of your customers which you supply our product to and we see no reason why you should not explain this to your customers who have received these letters from the Dow Chemical Company and as a matter of fact we have no objection to you showing them the letter in substantiation of your position with us in connection with this patent and also your position with us in connection with your customers.

"Should any of your customers at any time receive official notice of suit being filed against them, they should, of course, refer any and all correspondence to you immediately and you in turn pass it along to us.

"Yours very truly,
The Grasselli Chemical Co.
H. M. Rosenerans,
Western Division Sales Manager."

The Court: Were you receiving threats during the time you were using that acid you bought down in Detroit? A. I don't remember, Your Honor, whether we received letters then or not. It seems to me these people we treated for received letters, but I couldn't give you the date they received those.

The Court: You were having trouble then in your field about your acid, and by trouble I refer to from the Dow, before you bought that inhibited acid, and you were using the regular acid, were you not? A. You mean we were having trouble from the Dow?

The Court: That is open to all the objections they urged against your question, but it is of the same type, it is that hearsay type. Were you having trouble out there from the Dow while you were using that acid you bought in Detroit? A. I couldn't say. I don't remember whether we had the letters then or after we used from Grasselli.

The Court: Before you had letters were there men selling acid to your customers? Were you getting complaints back from your customers that they were getting scared? A. On Dow's patent?

The Court: Yes. A. I couldn't say. I don't remember at that time.

The Court: All right.

Mr. Conner: I show you another letter on the letterhead of the Grasselli Chemical Company, dated January 26, 1933, addressed to Edgar Lee, the Oil Maker Company, Mt. Pleasant, Michigan, signed the Grasselli Chemical Company, H. M. Rosenerans, and ask it be marked as PX-202,

and I ask you, Mr. Lee, if you have seen that letter before, and if so, approximately when?

(The letter above referred to was thereupon marked Plaintiff's Exhibit No. 202.)

Mr. Owen: May I suggest right here, Your Honor, that the Grebe-Sanford patent did not issue until September 13, 1932, so there couldn't have been any notice of infringement before that time.

Mr. Lyon: They could talk about the fact they were going to get a patent and sue as soon as they got it.

Mr. Owen: They didn't know they were going to get one.

Mr. Lyon: They claimed they were.

The Court: What is the date of the Grebe patent?

Mr. Owen: September 13, 1932.

The Court: Well, now, that looks to me as if Mr. Dow as quick as he found out he had a patent sent out his notices to everybody in the field, rather than that he had just found out two days before or three days before he had ordered some inhibited acid from Cleveland.

Mr. Conner: That could well be. We don't know.

The Court: I say that is what it looks like.

Mr. Conner: We do not know.

The Court: It doesn't look as if the fact they had shifted from the clear acid to the other, or had heard about the use of that clear acid, and he didn't know whether it was inhibited or not?

Mr. Conner: It could well be.

The Court: I think that is the common sense conclusion to reach from that discussion.

Mr. Conner: Yes, I am inclined to agree with you. I don't think the Dow Chemical Company knew what kind of acid was being used.

The Court: They knew they got a patent and they knew their acidizing was not it.

Mr. Conner: One of those two things, or both of them.

Mr. Wiles: Our notice was limited to reference to the patent. It is the common type of practice, if you are using anything in here you get off.

The Court: All I was drawing a conclusion that what I was guarding myself against was reaching the conclusion that there is any inference that the Dow Chemical Company thought or knew that this was inhibited acid, or had any reason to think it was at the time they sent that notice.

Mr. Lyon: Their position today seems to be about the same as that. They want to put you out of the acidizing business, not out of the use of the inhibitor.

The Court: They have got some of yours and analyzed it, but I don't think they had then.

Mr. Lyon: It took a long time to invent a theory of infringement for this case.

Mr. Wiles: It took a long time to get a sample. The minute a sample was gotten it was clear enough it was infringing acid.

The Court: I think we are all in agreement about what happened about these notices, and I was just emphasizing there that it doesn't look as if the change in the use of that acid that came in there about that time had anything to do with this notice, and that what that notice was based on was the use, as a matter of fact, of the acid that was not inhibited.

Mr. Conner: To be perfectly frank with you, Your Honor, I don't contend one way or the other, but I think when I get through with my proofs here you can make your decision for whatever phase of the matter or in whatever phase of the matter it affects this case.

The Court: I better wait and not make it now.

Mr. Conner: You rush me.

Mr. Conner: Will you please read this letter, Mr. Lee?

"January 26, 1933

"Mr. Edgar Lee,
"The Oil Maker Company,
"Mt. Pleasant, Michigan
"Dear Sir:

"As a matter of record we want to confirm conversation which we had with Mr. C. I. Dougherty on Monday, January 23, at which time we told him that our letter to you

in connection with the Dow patent on the use of inhibited muriatic acid in the treatment of oil wells, does not in any way cover anyone who would buy our Duclean 2-A from you, and use it in the treatment of oil wells. In other words, should you re-sell any of this product of ours, we can assume no responsibility in connection with the party to whom you sold it.

"I very much enjoyed meeting Mr. Dougherty and talking with him about the Texas and Louisiana activities, and the next time you come north, I would also enjoy having a little visit with you. I get over to Detroit quite frequently now and might be able to meet you there if you would let me know a few days ahead of time.

"Yours very truly,

"The Grasselli Chemical Company

"H. M. Rosencrans."

The Court: If I interpret that letter right they gave you protection. If you sold to other people they didn't believe their guaranty would go to them. A. As I remember it, we had some people that wanted to buy this acid and treat their own wells, and we asked them if they would still be protected against Dow's patent.

The Court: All right. A: I think that is the way it is.

At this point a letter on the letterhead of the Grasselli Chemical Company, dated September 15, 1932, from F. C. Zebornick to E. J. Lee, Midland, Michigan, and a letter dated October 8, 1932, addressed to the Grasselli Chemical Company, Cleveland, Ohio, attention Mr. Rosencrans, and signed the Oil Makers Company, Edgar S. Lee, were offered and received in evidence as PX-203 and PX-204.

The witness then read the letter (PX-203) as follows:

"September 15, 1932.

"E. J. Lee,
"Midland, Michigan
"Dear Sir:

"Shortly following our 'phone conversation this morning, the writer wired you as follows:

'Okeh to see our Mr. Rosencrans tomorrow at Cleve-

land office.' Confirmation of which we now attach hereto.

"We have already explained to our Mr. Rosenerans that it is your desire to discuss the subject of the use and purchase of inhibited muriatic acid for Kentucky and other districts.

"Hoping your visit will prove satisfactory and thanking you for giving us the opportunity to interest you, we remain

"Yours very truly."

The Witness: With respect to the carbon copy of the letter dated October 8, which is PX-204, I will state that the carbon copy I have here is a copy of the letter I sent on or about that date to the Grasselli Chemical Company. I will now read the letter.

"Midland, Michigan, October 8, 1932.

"Grasselli Chemical Company
"Cleveland, Ohio.

"Attention Mr. Rosenerans.

"Dear Sir:

"We would like to have you write a letter to Mr. H. C. Spillman of the Continental Motor Company of Muskegon, Michigan, telling that your inhibitor is 98 per cent perfect, and will form no corrosion or harm pipes in any way. Please write Mr. Spillman at once as he has about twelve wells to treat and is awaiting your reply before giving contracts for treating them.

"We will want another car of acid the first of the week, and will mail you a check for the car on Tuesday.

"Yours very truly,
"Oil Maker Company,
"Edgar S. Lee."

The Witness: As I understand it the Duclean 2-A was 98 per cent perfect. Well, anyway, it would not eat up the pipe up to 98 per cent. I am not a chemist. I cannot explain it to you in those terms. It was 2 per cent from being perfect. You could throw pipe into your acid and practically no harm would come to it at all.

The Court: How did you happen to have any worry up in Muskegon about that, anyway? What started that about your acid going to eat it up? A. I think we used some raw acid over there first.

The Court: Hadn't anything been eaten up yet? A. We had trouble there.

The Court: Trouble making sales and getting jobs is all. A. No, as I remember, we had trouble with pipe and tubing. I think Mr. Dougherty looked after that.

The Court: You were trying to make another sale over there. A. That is true.

The Court: Well, did you have any competition? A. Yes.

The Court: What was your competition? A. The Dow was treating.

The Court: And who was talking about pipe standing up? What started that talk? A. Well, as I remember, we had some trouble with tubing over there on another lease. This man was a little leery of this acid we used.

The Court: What made him leery? What started that talk? Do you know? A. I couldn't say. He talked to some of these other men, treaters that owned other wells.

The Court: Some of your competitors you mean? A. I wouldn't say that because I wouldn't know.

The Court: It sounds so to me. You are trying to sell your acid. You are trying to get your man to write him a letter about acid 98% pure. A. Sure. That's right.

The Court: Do you know how he happened to find out that the pipe had been eaten in the well? A. You mean this gentleman here?

The Court: The Muskegon man. A. The man we had Grasselli write the letter to?

The Court: Yes. A. I don't think we treated any wells for him. We were trying to get to treat his wells.

The Court: What started him worrying about the well being eaten up with acid? A. Nothing. Unless he started to talk with the other men in the field that had had wells treated.

CROSS EXAMINATION

By Mr. Lyon:

Q. When you got this letter from The Dow Chemical Company calling attention to infringement of the patent in the middle of 1932, did you get a copy of the patent? A. No.

Q. Didn't pay any attention to the patent?

Mr. Wiles: The letter says the patent is enclosed.

A. The letter may have said.

Q. Did you read the patent, attempt to find out what the patent covered? A. I don't remember.

Q. Did you take it to any attorney? A. No.

Q. You didn't make any investigation to see what that patent covered at all? A. Not to my knowledge, no.

Q. At that time your company wasn't in very good financial position, was it? Didn't have money to spend on lawyers or anything like that? A. That is right.

Q. Pretty far behind on your accounts in paying for this acid, weren't you? A. No.

Q. Weren't you behind with the Pennsylvania Salt Company? Didn't they refuse you credit? A. I don't believe they did.

Q. Don't tell me you don't believe they did. Didn't you have to go to Grasselli because Pennsylvania Salt refused you credit?

The Court: How much money did you have? A. Not very much, Your Honor.

The Court: How much? A. $500 or $600.

The Court: All told? A. Yes.

The Court: That was your capital? A. Yes.

Mr. Lyon: Now, when you proposed bringing this acid up from the Pennsylvania Salt Company in this steel tank, whose idea was that? A. Why I guess it was Mr. Dougherty's and mine.

Q. Did you see anybody else using steel tanks around your part of the country? A. No, I don't believe we did.

Q. What was Dow using to deliver their acid? A. I don't know.

Q. How did you get the idea of using the steel tanks instead of a wooden tank? A. We didn't know. We just got a tank. Nobody knew nothing about the acid business at that time.

Q. Did you pay for having a steel tank made? A. No. We bought it.

Q. How much did you pay for it? A. $30.00, $35.00 for it.

I do not know why we wished to ship the acid in a steel tank. A wooden tank cost, according to the invoices, $150 to $154. I do not believe that we compared the wooden and steel tanks before we went to the Pennsylvania Salt Manufacturing Company for the acid. Mr. Dougherty and I first went down to the Pennsylvania Salt Manufacturing Company to arrange for buying some acid. We asked for acid that was used to treat wells. They knew what we would want down there. I do not know whether they were also selling acid to other people for treating wells at that time.

When we sent the steel tank to the Pennsylvania Salt Manufacturing Company at Wyandotte, Michigan, to obtain hydrochloric acid in it, Mr. Parks, their general manager, called us up and told us that he would not ship the acid for us in a steel tank because it would eat the tank up before we got it back to our place. I am sure that he said that. I have not had any experience to know whether or not this would be true. I have never tried it. It would take about six hours for the acid to come from Wyandotte, Michigan, up to our place at Midland, if we were going to haul the acid in that steel tank. I do not know how thick the steel tank was. It was an oil tank that we got from the Standard Oil Company at Saginaw. I think the tank was about ¼ inch thick, but do not know how old it was, but it was a clean tank. It had been painted and it looked like a good tank.

When we bought the two wooden tanks from the Kala-

inazoo Tank & Silo Company, one invoice stated "Paint inside of tank with asphalt paint" and the other invoice stated "Paint inside of tank as per wire." I do not know why they did this. I suppose it makes the tank more waterproof, or perhaps the acid doesn't eat the wood. I couldn't say. Maybe it makes the tank last longer.

I cannot say when we actually stopped this acidizing business and went out of business and discontinued treating wells. I do not know the last well that we treated or on what date it was. As nearly as I can remember we discontinued this business after the banks closed, which was about February, 1933. I do not believe we still had our $600 in the bank when we quit business.

Mr. Lyon: You had a guaranty from Grasselli, and you had an inhibited acid, what did you go out of business for? A. Well, oil went down to 10 cents a barrel, and the banks closed up.

Mr. Lyon: You said that there was some trouble about something that you had done with this Penn Salt acid. Do you really know about that trouble, or is it very vague in your mind? Can you give us the facts about it? A. Well, the only fact that I can give you is that the only pipe I saw was this pipe that came out of the McClanahan well.

Q. Now, were you there when the McClanahan well was treated? A. Yes.

Q. How long was the acid in that pipe going down the well? A. Oh, probably two or three hours they were putting it in.

Q. How long was it in? A. Maybe two or three hours.

Q. I am not asking you maybe.

The Court: Well, as near as he can tell. A. I can't give you the exact minutes or time.

The Court: It was about that as near as he can tell.

Q. All right. What kind of tubing was in that well, do you know what size it was? A. I believe it was a 2-inch.

Q. Was it new tubing? A. That I couldn't say.

Q. Do you know what condition the tubing—how long

it had been in the well before you acidized the well? A. I couldn't say that either.

Q. You don't know anything about the tubing before you acidized—the condition of the tubing? A. No, I couldn't tell you.

Q. When you saw this tubing after the job had been done, were there any holes in it? A. No, there was not. There were little pits in it. The pieces that I saw that their man showed me, there were little pits in it. I didn't see the working barrel. All I saw was a few lengths of tubing.

Q. How thick was that tubing? A. It was regulation size tubing. I couldn't give you the exact thickness.

Q. About a quarter of an inch thick? A. I don't think tubing is that thick.

Q. How thick was it? A. I couldn't give you the exact measurements, because I don't know.

Q. It was just pitted a little bit on the inside? A. This was on the outside that I saw.

Q. Pitted on the outside. You didn't get your acid pumped away from the tubing? A. Perhaps not.

Q. Was there any pitting on the inside of the pipe, or did you look? A. I don't know. I just saw these two or three lengths of pipe that this man showed me.

Q. Was there any complaint about pitting on the inside of the pipe in any of these cases that you talked about? A. You mean in this case here or do you mean on the inside of the pipe?

Q. The acid goes down the inside or outside, which? A. Goes down the inside. Sometimes they don't use any tubing at all.

The Court: Where did you put it down? A. This well, it was put down through the tubing.

Mr. Lyon: Was there any complaint that the acid had hurt the tubing on the inside? A. I wouldn't say about the inside.

Q. Was there any complaint about the inside? A. That I couldn't say. It was the outside that he showed me and complained about.

Q. How many joints up from the bottom was he complaining about it on the outside of his tubing? A. He showed me two or three joints.

The Court: From the top of the well or bottom? A. That came out of the bottom, he said.

Mr. Lyon: And tell the court how much pitting you saw there on the outside of the pipe? A. We saw pitting on this bottom pipe, not so much.

Q. Do you think there was an alarming amount of pitting? A. There was some, yes.

Q. How much? A. I couldn't describe to you how much, but there was some pitting on the pipe.

Q. How deep were the pits, do you know? A. No, I couldn't say.

Q. Were they very deep, or don't you know? A. I don't know.

Q. Had the pipe been cleaned up when you saw it, these joints of pipe cleaned up? A. I don't believe so. It laid there on the rack.

Q. Were they rusty or not? A. I don't remember.

The Court: The man is here that showed it to you? A. No, this man isn't here.

Mr. Lyon: Well, who was present when you saw this pitted pipe, anybody but you and this other man? A. When I was there that was all, but I believe Mr. Dougherty and Mr. Sprenger saw this pipe also.

Q. Are they here? A. Yes. I wouldn't say for sure, because I don't know.

Q. They didn't see it when you saw it? A. No.

The Court: Where is that man that showed it to you? A. I don't remember his name.

Mr. Conner: Do you remember the name of that well in the McClanahan? A. I think it was the Schaffer well.

The Court: Is that the one he was talking about?

Mr. Conner: Yes.

Mr. Lyon: Can you tell us the date on which you acidized that well? A. No.

Q. Can you tell us the name of the company you acidized it for? A. McClanahan.

Q. Can you give us the location of the well? A. It is in Greendale.

Q. Is that as near as you can locate it? A. It is between Midland and Mt. Pleasant, about twelve miles out of Midland, on the Mt. Pleasant Road.

The McClanahan Oil & Gas Company has more than one well located in this district. I think Mr. Sprenger put the acid into this well. I do not remember the name of the McClanahan Oil & Gas Company's field man that was in charge of this well. I think it was the Schaeffer well, but I wouldn't say for sure. I do not remember the date when the well was treated, nor can I tell you the date when I went out there and looked at this tubing. It was perhaps a week or ten days after the job of acidizing this well that I went out and looked at the tubing.

Mr. Lyon: Did you actually reimburse these people or pay them anything for this damage you did outside of this tubing? A. It seems to me that we done—the way we paid some of them, we done some free treating for them.

Q. Did you do that for these people you were talking about? A. I believe we done some free treating.

Q. Well, did you for this company? A. I wouldn't say for sure, but I am under the impression we did.

Q. Well, did you pay them any money? A. No, I don't believe we paid them any money.

Q. Well, what did you treat for them free and when? A. That I couldn't say.

The Court: With the same kind of acid? A. I don't know what acid we did use afterwards.

Q. How long after you saw this damaged tubing was it before you did this free treatment? A. I can't remember.

Q. Did you produce all the letters and correspondence you had with Grasselli about this acid that you were going to buy from them? A. Do you mean the letters and correspondence you have here?

Mr. Conner: I submit this witness didn't have custody of these letters, and I will put the gentleman on the stand who did and you can ask him.

A. (Continued): I had no letters, no.

Q. These letters, many of them were addressed to you personally? A. That is right.

Q. Where is your file? A. Mr. Dougherty had the letters and things at Mt. Pleasant after we moved there.

Q. Do you know whether this is all the correspondence you had with Grasselli on this subject? A. I couldn't say. I don't remember.

Q. Now, you started in acidizing wells, or formed this little business what time, in June, 1932? A. Oh, I wouldn't say the exact date of it, because I don't remember that.

Q. Well, as near as you can. A. It was in the summer of 1932.

Q. As near as you can when was it? A. It might have been June, July; in there some time. It was in the summer I know.

Q. Is that as near as you can fix the date? A. Yes.

Q. Now, was there anybody else in the acidizing business at that time, or any companies acidizing their own wells before you went into the business? A. It seems to me that the Pure Oil Company were acidizing their wells.

Q. Had Dow started anything when you went into business? A. I don't remember.

Q. But the Pure Oil Company, that was where you got the idea of acidizing wells, from the Pure? A. Why, I don't know where the idea really did originate from.

Q. I mean so far as you are concerned, where did you get the idea? A. Well, we have discussed it among ourselves, that is all. Mr. Dougherty is an oil man, and Mr. Sprenger.

Q. It was not your idea then? A. No, I guess it was all of their idea.

Q. How did you come to get into this thing? A. I knew Mr. Sprenger and Mr. Dougherty, and we had been interested in some oil wells.

Q. Who suggested that you go into the acidizing business? A. I do not know.

Q. Do you know whether you did, or not? A. I couldn't say.

Q. Did you ever take up with the Penn Salt Company, or, did you ever report to the Penn Salt Company, or advise them that you were having any trouble, or any complaints about their acid causing any pitting of any pipe? A. I don't remember.

Q. Or any damage to any pipe? A. I don't remember.

Q. You do not remember? A. No.

Q. Did you advise the Penn Salt Company why you were discontinuing buying acid from them? A. I think we told them that we wanted an inhibited acid, sir.

Q. And did they say that they would not give it to you? A. I don't think they had an inhibited acid.

Q. Did you do this in writing? A. No, I don't believe it.

Q. Did you personally go down and talk to the Penn Salt Company about inhibited acid? A. I talked to their man once about if they had inhibited acid.

Q. What man? A. One of their chemists. I don't remember his name.

Q. Where was this conversation? A. That was in one of their offices, in the Penn Salt.

Q. And when was that, about when relative to these other things? A. It was in the summer some time.

Q. Was there anybody else using inhibited acid up in your territory in the summer of that year? A. I don't know.

Q. Where did you get the idea about inhibited acid, where did you hear about it? A. I think Grasselli's men were around up in there selling it, and I think they contacted us first.

Q. What Grasselli men came to you? Did Grasselli men come to you and tell you that you had better buy inhibited acid, instead of the Penn Salt uninhibited acid? Is that right? A. They came to sell their acid.

Q. The sales point that they made to you that it was inhibited? A. They had an inhibited acid, yes.

Q. And that was the first time you ever heard of it? A. Of inhibited acid?

Q. Yes. A. I don't remember.

Q. You had never bought any inhibited acid up to that time, that you know of? A. No.

Q. Did they tell you that if you bought inhibited acid from them, then you could go out and use that sales argument with your customers that you had an inhibited acid? A. I believe that was one of the arguments, yes.

Q. You never gave the Penn Salt Company an opportunity to demonstrate to you whether their acid would injure pipe in a substantial way, or gave them an opportunity to say whether they would furnish you with inhibited acid? A. As I remember it, I don't think they had inhibited acid, or didn't want to bother with inhibited acid.

Q. What did they say about the difference between inhibited acid and uninhibited acid? A. I don't remember.

Q. I mean, the Penn Salt Company? A. I don't remember.

Q. They said that they did not want to bother with it, didn't they? A. I don't remember what they did say.

Q. Was there anything in writing about this? A. I don't believe there was, no.

Q. The only particular incident that you can tell us specifically about, where you had any pitted pipe, or anything of that kind, is this one Flannigan well, is it? A. The McClanahan well.

Q. That is the only one that you saw? A. That is the only one that I saw, yes.

Q. Do you know for a fact that your company ever paid any money to anybody to reimburse it for any damage to any pipe? A. It seems to me that we paid for some tubing over in Muskegon.

Q. How much tubing? A. I don't know.

Q. You don't know? A. That I couldn't say.

Q. Who to? A. I don't know.

Q. When? A. That was in the summer of 1932.

Q. When in the summer? A. Well, I would not say.

Q. You say that it seems to you? A. Yes.

Q. Are you sure of this thing, or are you just— A. (Interrupting): You mean, am I positive about it?

Q. Yes. A. No, I am not positive.

Q. You cannot give us the name of the company? A. No.

Q. Or the date? A. No.

Q. Or the amount that you paid out? A. No.

Q. Or the amount of the tubing that was involved? A. No.

Q. Did you ever have any complaint about your Penn Salt acid injuring the pipe, or pitting the pipe anywhere except down at the bottom of the pipe, and around the outside? A. Oh, you mean up at the top of the pipe, or something like that?

Q. Yes. A. No, not to my knowledge.

Q. No complaints at the top, or in the inside of the pipe? A. Not to my knowledge, no.

Q. The only complaints were around the outside, at the bottom, is that right? A. I believe that is right.

The Court: Can you tell me about how many wells your outfit—whether it was a copartnership or corporation—treated altogether? A. About, I would say perhaps 100.

The Court: Can you tell me where those were located as nearly as you can, as to how they would be divided, as to location? A. In Michigan? You want the places in Michigan?

The Court: Well, yes, divide them as to Michigan, Muskegon, and over here in this field, as well as you can. You think all told, one hundred, and you don't make these exact, as I understand you. A. No.

The Court: That is your best estimate? A. Yes, sir.

The Court: Now, in the same way, as near as you can, tell me what fields those wells were located in. A. Mt. Pleasant field—Greendale field.

The Court: About how many would you say out of the one hundred all told, there? A. Oh, I would say maybe twenty-five.

The Court: Now, the next field? A. Muskegon.

The Court: How many would you say? A. Why, I would say maybe twenty, twenty-five.

The Court: And what other fields? A. Then we treated in Breckenridge, Texas.

The Court: How many do you think at Breckenridge, Texas? A. Maybe fifteen or twenty.

The Court: And what other fields in between? A. We treated in Louisiana I would say probably about the same amount.

The Court: Fifteen or twenty. A. I couldn't give you exact on those, Your Honor.

The Court: Any other fields? A. We treated two wells, I think, in Oklahoma.

The Court: Any other place? A. No, I believe that is all. That might vary one way or the other on those.

The Court: Well, your maximum adds up to 92. Taking your estimates it would be Mr. Pleasant 25, Muskegon 25, Breckenridge, Texas, 20, and Louisiana 20, and Oklahoma 2. That would add up on that basis to 92. A. Possibly you might have more.

The Court: Well, did some of the members of your organization go down to these distant places? A. To Texas and Oklahoma, you mean? Yes, Mr. Dougherty was down there and I was down there.

The Court: Now, how many of those would you—as near as you can tell me, were with acid and how many by inhibited acid? How can we make that split? A. I couldn't say, Your Honor. We might have treated more wells than one hundred wells, I would say.

The Court: You think probably if you was going to raise those, I have only got up to 92 was the highest estimate. Which would you raise, you think, more? A. We treated more with inhibited acid than we did with the other acid.

The Court: How many do you think you treated with the raw acid? A. Why, maybe 20, 25.

The Court: Well, then, you think the balance of them would be inhibited? A. Yes.

The Court: And as nearly as you can tell, was it a clear cut shut off when you got through with inhibited—or the raw acid and you went to using inhibited, was it cut off at a certain time or was there a period when you were using both, do you think? A. It seems to me we ran out of acid once when they were shipping it to us out of Cleveland in tank cars, and it seems to me we went down maybe once or twice, when we were out of acid, and got another lot of acid.

The Court: After quitting using raw acid then you went over to the inhibited and you found some little difficulty about getting inhibited, you think you went back to the raw acid? A. I think we used a load or two, yes.

The Court: Well, now, when do you think it was that you—well, you think you have shown me the bills for the first inhibited acid you bought here?

Mr. Conner: I have the actual cancelled checks in payment for acid from both Penn Salt and Grasselli, and I have old bills and invoices, and if you like I will re-examine this witness to see what he knows about them, but the papers I have did not come from his files.

The Court: What is the earliest invoice you have got, or is it a check, for the first acid?

Mr. Conner: The earliest check I have here, and I don't know that that is complete, I will have to find out from the witness, the earliest check I have here in payment to the Penn Salt Manufacturing Company is August 9, 1932.

The Court: That is for raw acid, I take it?

Mr. Conner: Well, the earliest check I have here for payment to Grasselli is September 19, 1932.

The Court: That is the one you spoke about. All right. And then you think after that you still bought some more raw acid? A. I believe we did, Your Honor, yes.

The Court: Can you tell me somewhere near when that was? A. Maybe in September or something like that. I wouldn't try to tell you the exact date.

The Court: Well, was it a long while after you had

begun the use of inhibited acid? A. Not such an awful long while.

The Court: Now, can you tell me the fields in which you used raw acid in that way? A. We used raw acid in the Muskegon field and in the Mount Pleasant field (Michigan).

The Court: Any other field? A. No.

REDIRECT EXAMINATION

By Mr. Conner:

Q. Did you use the acid from the Penn Salt any place other than just in Michigan? A. No. That is all.

The Court: And he has told us the two fields and he used it in both, Mount Pleasant and over in Muskegon.

Mr. Conner: Now, when you purchased acid from the Penn Salt Company, do you remember any particular incident relative to trying to store that acid? A. Yes. We brought it in. You see, when we brought the acid up it was quite strong. It was too strong to use in the wells. And we brought it up and put it in some vinegar barrels and it slopped over or something and ate the hoops off the barrels and ran out on the cement floor.

Q. Ate the metal hoops off the barrels? A. Yes.

Q. Will you tell me what kind of tanks you and your partners used in transporting acid out to the fields here in Michigan after you started purchasing Grasseili Duclean acid? A. We used some steel tanks we had made by the Wicks Boiler at Saginaw.

Q. What if any trouble did you have with respect to the acid eating up those tanks? A. We didn't lose any tanks.

The Court: Now, you used inhibited acid, of course, for that? A. When we was using steel tanks?

The Court: Yes. A. From Wicks?

The Court: Yes. Had you heard that there was a patent that had been issued that told you that you could transport in steel tanks if you had it inhibited? A. No. It seems to me that DuPont's man told us it would be all right for us to use steel tanks for the inhibited acid.

Mr. Owen: I stated before the recess that I thought I might throw some light on where Mr. Blum got his information about these early acid treatments. It is in the form of a number of items published in the Oil City Derrick, during the period that Van Dyke and Frasch were carrying on their operations near Lima. The Oil City Derrick, I understand, was the leading publication in the oil industry way back at that early date, and it later became the Oil and Gas Journal, which is now one of the leading publications in that field.

The Court: The publication we did have (PX-93), that one article was in what?

Mr. Owen: That was in the Oil City Derrick.

The Court: I take it that we are pretty safe in saying that it had its origin with Van Dyke; he had this in his file, and then he and somebody they got to do it wrote it up.

Mr. Owen: It was prepared for this purpose, I understand.

The Court: Yes.

Mr. Owen: I offer as PX-142 a Carnegie Library Card showing what files of the Oil City Derrick are contained in that library; also as PX-143 to 149, inclusive, photostatic copies of portions of the issues of that publication for October 28, 1895, November 9, 1895, January 15, 1896, February 20, 1896, February 22, 1896, March 26, 1896, and August 10, 1897, respectively.

The Court: Are there other trade publications covering this subject that have not been searched? You have looked in the most likely places and the best publications, probably, to look, but sometimes they are not so conspicuous a publication that will carry it.

Mr. Lyon: We haven't found any other publication of those dates that offered any promise of disclosing any articles about this thing.

Mr. Conner: The Oil City Derrick was published right up in Oil City, Pennsylvania, right in the heart of the original Pennsylvania wells, very close to where the original Drake well came in.

The Court: Now, when you came to look for articles on the subject we are interested in, did you just search those newspapers, one copy after another?

Mr. Owen: Yes, that is true, Your Honor.

Mr. Lyon: Had to read every issue to see if we could find something.

CHARLES I. DOUGHERTY,

a witness called by plaintiff, testified as follows:

DIRECT EXAMINATION

I live at Mt. Pleasant, Michigan, and have lived there for 11 years. I am in the oil well drilling and contracting business, have been in that business off and on for about 30 years and have operated in the states of New York, Pennsylvania, Ohio, Michigan and Texas. At present I am still in the same business and am operating in Michigan.

I know Edgar Lee and was connected with him in a business venture which had to do with treating oil wells with acid for the purpose of increasing their production. I had a partner in the contracting business named Fred Markey, and the two of us, with Edgar Lee, formed a company, which was called the Oil Maker Acid Company. This was about the middle of June, 1932, and we incorporated under Michigan law shortly after we formed the company. We rendered a service of putting acid in oil wells to increase their production. We operated in Michigan from about the latter part of June, 1932, up until, I believe, the latter part of 1933. I am not just positive of that. We operated in Michigan, Texas and Louisiana. I would say that we probably treated with acid during the time we were in business about 250 wells. I have records with me which would enable me to more correctly ascertain the number of wells that we treated. I think I have all the records here, but I do not know. There were a couple of cases full of them, but I didn't bring them all. We kept a separate record for each well that we treated.

Our intention was to make some money, and the service that we rendered in practically all cases was an attempt to increase production of an oil well. We were a service company treating oil wells with acid to increase production and to make money.

At first we purchased the acid from the Pennsylvania Salt Manufacturing Company of Wyandotte, Michigan. That is just out of Detroit. We purchased acid from these people from the latter part of June through July and I believe somewhat in September of 1932. I am not positive whether we purchased any acid from these people in August, 1932, or not.

I have examined a set of checks commencing with the date of August 9, 1932, and ending with the date of October 18, 1932, all of which are made "pay to the order of Pennsylvania Salt Company" and signed by the Oil Maker Company by Grace Farmer in some instances and in other instances signed Oil Maker Company by Edgar Lee, and I identify these as checks that were issued by the Oil Maker Company, in payment for purchases of acid from the Pennsylvania Salt Manufacturing Company.

At this point the checks paid to the Pennsylvania Salt Maufacturing Company between the period August 9, 1932, and October 18, 1932, were offered and received in evidence as PX-205.

The Witness Continuing: I will now read the number, date, and amount of each of these checks constituting PX-205.

Check #6	August 9, 1932	Amount $35.61
Check #8	August 15, 1932	Amount $35.61
Check #9	August 16, 1932	Amount $53.76
Check #10	August 17, 1932	Amount $53.76
Check #11	August 18, 1932	Amount $35.61
Check #12	August 18, 1932	Amount $53.76
Check #13	August 18, 1932	Amount $18.15
Check #14	August 20, 1932	Amount $53.76
Check #15	August 20, 1932	Amount $35.61
Check #17	August 24, 1932	Amount $54.76
Check #21	August 26, 1932	Amount $35.61
Check #22	August 27, 1932	Amount $71.22
Check #25	August 31, 1932	Amount $68.88
Check #31	Sept. 1, 1932	Amount $68.88
Check #32	Sept. 3, 1932	Amount $39.26

Check #33	Sept. 8, 1932	Amount $53.14
Check #34	Sept. 9, 1932	Amount $93.87
Check #35	Sept. 12, 1932	Amount $93.87
Check #42	Sept. 16, 1932	Amount $53.14
Check #59	Sept. 30, 1932	Amount $35.42
Check #73	October 17, 1932	Amount $88.56
Check #74	October 18, 1932	Amount $88.56

All of the checks, invoices, or other papers or letters that I will be talking about here today came from our files at Mt. Pleasant, Michigan. I have had them in my possession since this company ceased to operate.

The invoice of the Pennsylvania Salt Manufacturing Company, dated July 25, made out to the Oil Maker Company, for 530 gallons of muriatic, of 18° Baumé, shows that we bought and paid for that amount of acid from this company. This invoice was probably given to a truck driver. This acid was bought and paid for by our company, by our check Number 8 dated August 15, 1932, that check being in the amount of $35.61.

I have examined certain invoices from the Pennsylvania Salt Manufacturing Company to either E. J. Lee Company or the Oil Makers Company, these being invoices #199, dated August 5, 1932; #200, dated August 6, 1932; #203, dated August 10, 1932; #204, dated August 12, 1932; #208, dated August 16, 1932; #209, dated August 16, 1932; #213 dated August 27, 1932; #212, dated August 19, 1932; #218, dated August 27, 1932; #220, dated August 31, 1932; an invoice dated September 17, 1932, and invoices #320, dated October 17, 1932 and #231, dated October 18, 1932, and all of these invoices show materials that were purchased from the Pennsylvania Salt Manufacturing Company by us, and the materials purchased were muriatic acid.

I have examined the checks that my company paid to the Pennsylvania Salt Manufacturing Company, and the invoices that the Pennsylvania Salt Manufacturing Company issued to my company, and I find that the invoices bear a check number, which checks I have in hand, and

which invoice I have in hand, to show that certain checks were issued in payment of these invoices.

The Court: You are saying, witness, that for every invoice that you have there was a check, and you did pay for it? A. Yes.

The Court: And you say that for every check you wrote there was an invoice, and the acid was delivered to you?

Mr. Wiles: The witness said he paid for the first one in cash money. A. Yes, the first few trips.

The Court: You are saying that every time you find an invoice, that it got paid, and that every time there is a check, that they got it, and they didn't get paid twice? A. Yes.

The Court: I am satisfied with that kind of proof for this kind of thing. It seems very complete for the purpose for which you introduce it.

At this point the invoices from the Pennsylvania Salt Manufacturing Company commencing with the date July 24, 1932, and continuing to invoice dated October 18, 1932, and issued to the Oil Maker Company or Edgar Lee, were offered and received in evidence as PX-206.

The Witness: I and my partners in the Oil Makers Company were in the business of acid treating oil wells in Michigan, and we started in this business about June 22, 1932. When we first started in this business we purchased our hydrochloric acid from the Pennsylvania Salt Manufacturing Company at Wyandotte, Michigan, but I had bought one load of acid from The Dow Chemical Company before purchasing acid from the Pennsylvania Salt Manufacturing Company, and sent that acid to Ohio where I used it on some property I owned down there. But this was before the Oil Maker Company was formed, and it was in the early part of June, probably the 1st of June, 1932. I have no record of this purchase of acid in my book, I probably have it in some other records. I do not now recall in what type of container I received the acid when I purchased it from The Dow Chemical Company. I do not recall whether it was a

Dow truck that took it for us, or what it was. The acid was taken to Wooster, Ohio, where it was used in one of the Dougherty Brothers wells.

While we were in this business of treating wells with acid, we treated for practically all of the oil companies in Michigan. We treated wells for the Columbia Oil & Gas Company, Gordon Oil Company, McClanahan Oil & Gas Company, Stork Oil Company, Malcolm Oil Company, The Moline Oil Company, and the Witt and Nelson Oil Company.

I knew that the acid that I purchased from the Pennsylvania Salt Manufacturing Company was not inhibited. I knew this because I made a trip down to Wyandotte, Michigan, to see about this acid, and these people had no inhibitor. It was the acid I purchased from the Pennsylvania Salt Manufacturing Company that I was using here in Michigan in treating wells.

As to the invoices from the Pennsylvania Salt Manufacturing Company to the Oil Makers, the only ones that I have here which reflect the purchase of acid from this company after the last day of August, 1932, are the invoices dated September 17, October 17 and October 18, 1932, each for 1000 gallons of acid, and each costing $88.56.

I have examined a number of checks all made payable to the order of the Grasselli Chemical Company, these checks commencing on the date of September 19, 1932, and ending with the date of April 15, 1933. I have examined these checks and they reflect the purchase of materials from the Grasselli Chemical Company on or about some time near the date of the checks and show that the Oil Maker Company or the Edgar Lee Company bought certain materials from the Grasselli Chemical Company.

These checks are as follows:

Check #46	September 19, 1932	Amount $475.00
Check #47	September 20, 1932	Amount $ 71.75
Check #48	September 23, 1932	Amount $ 71.58
Check #49	September 20, 1932	Amount $ 35.76
Check #60	September 29, 1932	Amount $475.00

Check #72	October 11, 1932	Amount $435.00
Check #76	October 25, 1932	Amount $500.00
Check #86	November 9, 1932	Amount $500.00
Check #89	November 17, 1932	Amount $441.00
Check #8	January 10, 1933	Amount $400.00
Check #24	January 26, 1933	Amount $300.00
Check #25	January 28, 1933	Amount $ 90.62
Check #33	March 29, 1933	Amount $200.00
Check #38	March 31, 1933	Amount $ 50.00
Check #42	April 10, 1933	Amount $ 50.00
Check #44	April 15, 1933	Amount $ 50.00

At this point the above-referred to checks were offered and received in evidence as PX-207.

I have examined certain invoices from the Grasselli Chemical Company, being invoice No. 30032, dated September 22, 1932; No. 90631, dated September 29, 1932; and No. 91183, dated October 17, 1932, these being invoices issued to the Oil Makers Company from the Grasselli Chemical Company, and all of these invoices show that the Grasselli Chemical Company sold to the Oil Makers Company Duclean No. 2 acid. On each of these invoices from Grasselli to the Oil Makers Company, the material sold is identified as being Duclean acid.

At this point the above-referred to invoices Nos. 90631, 91183 and 30032 were offered and received in evidence as PX-208.

At this point there was read in evidence the following portion of a deposition of

ARTHUR S. WEYGANDT,

taken by defendant in this cause at Cleveland, Ohio, on Tuesday, April 22, 1941:

"Q. Will you give your full name, please? A. Arthur S. Weygandt.

"Q. Your address? A. 1052 Roanoke Road, Cleveland Heights.

"Q. You are employed by the Grasselli Chemical Division of duPont? A. That is right.

"Q. What is your position? A. Manager of the General Research Section of the Chemical Division.

"Q. How long have you been with duPont or the Grasselli Division of duPont? A. I was with Grasselli from 1925, and it was taken over by duPont in 1929 I think.

"Q. At any rate, during 1932 you were employed by this company? A. That's right.

"Q. Are you able to state what the general nature of that No. 2 pickling compound was? A. No. 2 pickling compound, which we also term 'Duclean No. 2,' is an inhibited muriatic acid.

"Q. I ask the witness to state what his instructions were or what instructions were issued from this laboratory as to what agents should go into No. 2 pickling compound? A. The instructions from this laboratory called for the addition of a small amount of the complex organic compound which was the active inhibiting agent to commercial muriatic acid."

CHARLES I. DOUGHERTY (Continued)

The Witness: The Duclean No. 2 acid that we purchased from the Grasselli Chemical Company we hauled in an iron tank. When we purchased acid from the Pennsylvania Salt Manufacturing Company we hauled the acid in wooden cypress tanks. The wooden tanks were about 1000 or 1100 gallons capacity. When we were purchasing acid from the Pennsylvania Salt Manufacturing Company we used wooden tanks. When we were purchasing and using acid from the Grasselli Chemical Company we used steel tanks all of the time, not all of the time because we had two of these wooden tanks which were left over. We sent the steel tanks into Texas and Louisiana. We had two wooden tanks when we were using the Pennsylvania Salt Manufacturing Company's acid, and we had these tanks left over, and we also used steel tanks as well as wooden tanks when we were buying the acid from the Grasselli Chemical Company. When we were buying acid from the Pennsylvania Salt Manufacturing Company we sent an iron tank down there to get the acid. We were just going into this business and had contracted to do some work. We sent the trucks down to the Pennsylvania Salt Manufacturing Company and they refused to load them.

The amount of money indicated on the checks Nos. 6, 8 and 9 made payable to the Pennsylvania Salt Manufacturing Company on the dates of August 9, August 15 and August 16, 1932, respectively, do not indicate that these amounts of money were used to purchase acid for use in a single treatment. We would send a truck down to the Pennsylvania Salt Manufacturing Company and bring back a load, and then we would take out some of this acid and put in water to replace it. I think we brought back 1100 gallons. The tanks held about 1100 gallons. We would reduce it in half, that is half water, using about 550 gallons of acid.

The big majority of the acid treatments that we were making took about 500 gallons of acid. The acid that we

brought back from the Pennsylvania Salt Manufacturing Company was not diluted acid, but 30 per cent strength acid, so we would bring back 1000 gallons of that type of acid and dilute it down to 15 per cent strength acid, which would make 2000 gallons of diluted acid. We put about 500 gallons of diluted acid in the majority of the wells we were treating. So that out of 1000 gallons of acid diluted down to give 2000 gallons of diluted acid, we would treat about four wells using 500 gallons of diluted acid in each well.

Our company was treating wells here in Michigan during the months of July and August with acid that came from the Pennsylvania Salt Manufacturing Company. During the months of September and October of 1932, according to my checks and invoices, I also bought some acid at least from the Pennsylvania Salt Manufacturing Company. Also at that time, namely some time in September, according to my checks and invoices, I started to buy the Duclean No. 2-A inhibited hydrochloric acid from the Grasselli Chemical Company.

When we were using the acid from the Pennsylvania Salt Company we had some complaints of damages from the oil companies and operators relative to damage that the acid did to the well owners' equipment or tubing. We ruined a string of tubing for the Gordon Oil Company. That was very near a dry hole, and a hard type of formation to treat. I know that I was out there that night and we were about 24 hours putting the acid into the well. We would just run the pumps about 5 minutes at a time and get up to 1000 pressure and that was all that we wanted to put on the tubing, all of the pressure we wanted to put on. The formation was not taking the acid. In doing this and putting a shot of acid into the well, and that acid was pretty strong as it was, it ate the threads out in between the collars on the string of tubing and ruined the work. We did make a well out of this well, but we could not run the rods back into the well hole. I made a settlement for this damage with Howard Atha, who was president and

general manager of the Gordon Oil Company. Of course, the tubing was all right for line pipe afterwards. We allowed the Gordon Oil Company 5 cents a foot on a new string of tubing, but he used this old pipe for line pipe, that is for gas lines and oil lines on the surface of the ground. I actually saw this tubing which Mr. Gordon complained about. My recollection at this late date is that the threads of the tubing were eaten out in between the joints in the string of tubing. The threads would not screw together. The threads were all eaten out at each end, and that ruined the string of pipe.

In making an acid treatment to an oil well most damage is apt to appear at the bottom of the hole, because the acid is in contact with that part of the pipe longer, and also, even though the well is full of oil, the acid may contact the outside of the tubing. Some of the acid gets on the outside and gets on the collar and that does damage, while in any string of pipe, whether it is acid or anything else, the weak joint at the top is the worst. The weak joint of pipe on top of the string is the most dangerous, and the least dangerous weak joint would be the joint clear at the bottom of the well. This is because the top joint has to carry all of the weight below it. You lose less pipe if you lose it off the bottom joint than if you drop it off the top joint.

I have here a bill, dated September 30, 1932, made out on the letterhead of the Gordon Oil Company to Charles Dougherty, 502 S. Main Street, Mt. Pleasant, Michigan, reading "Damage to 2" tubing during acidizing of Taulker No. 2, 350 feet, September 17, 1932, at 5 cents a foot" and over at the side the bill says, "$175.00." This is a bill that the Gordon Oil Company sent to me. I paid the amount of $175.00 to the Gordon Oil Company and have a check to show that payment. This payment was made in settlement for damage done to the tubing of the Gordon Oil Company's Taulker No. 2 well. The check is dated October 10, 1932.

At this point the bill from the Gordon Oil Company

and the check in payment thereof were offered and received in evidence as PX-209 and PX-210.

The Witness: While we were in the business of treating oil wells we had other instances where complaints were received from the oil people alleging that we had damaged their equipment as a result of acidizing. We had a compaint from the Moline Investment Company of Muskegon, Michigan. We ruined quite a little bit of tubing for these people and I think I settled with Mr. Wolmer, who is here today, for $67.00. I do not recall any trouble of a similar nature with Nelson and Witt. I have examined a check made to the order of Nelson and Witt, dated September 23, 1932, being check No. 51 of the Oil Maker Company signed by Grace Farmer. The check is in the amount of $67.09. I have also examined a ledger sheet of the Oil Maker Company, on which appears an item under the date September 23, 1932, reading "Nelson and Witt tubing and labor, check No. 51, credit of $67.09," but I do not recall that these items reflect any trouble we had with Nelson and Witt. Nelson and Witt were in the business of oil producers. We were treating wells for these people, but this must be for something else (witness looking at ledger sheet) because I do not recall any damage that we caused to any of their wells. I knew that they were real pleased with our work.

I have examined page 3 of the ledger book of the Oil Maker Company and thereon, under the heading, Stork Oil Company, dated October 31, 1932, there occurs an item in pencil notation "Pipe damage amount $121.50." I know that my partner, Fred Markey, made a settlement with the Stork Oil Company. He was a partner with me in the Oil Makers Acid Company.

I have re-examined the check dated September 23, 1932, being the Oil Maker Company's check No. 51, payable to Nelson and Witt in the amount of $67.09 and have considered the ledger sheet of the Oil Maker Company and the items therein under the date of July 23, 1932. The ledger sheet shows moneys paid out by the Oil Maker Company, and on the ledger sheet under the heading "Explanation" appears the item dated September 23, 1932, under the head-

ing Nelson and Witt, and under the heading "Account Affected" it says tubing and labor. And then the ledger sheet says check No. 51, which corresponds to the check I have. The amount of the check, according to the balance on the ledger sheet, is $67.09. This amount in the ledger sheet corresponds to the amount appearing on the check I have in my hand. We would not have purchased any tubing from Nelson and Witt. I do not recall why our company would have paid this check to Nelson and Witt, nor what the check would be in payment for. I do not recall that we damaged the well for Nelson and Witt. I was not over there very much. Mr. Markey was there most of the time. I do not know what this check was in payment for.

At this point the Oil Makers Company check No. 51 to Nelson and Witt dated September 23, 1932, was offered and received in evidence as PX-211 and the ledger sheet of the Oil Makers Company was offered and received in evidence as PX-212.

There were other oil companies for whom we made acid treatments to wells and from whom we had complaints as a result of using hydrochloric acid in their wells. We had complaints from the Malcolm Oil Company. We had a complaint from the Stork Oil Company and we made a settlement with them. The settlements that we made with these oil companies were not always made by way of a cash payment. On different occasions we gave them a free treatment of acid, that is we treated a well for them for nothing.

We always used the same kind of acid in giving these free treatments by way of settlement. Sometimes the settlement was by way of treating the wells at half the price, or whatever it was. In other words, the operators of the oil wells, and the oil companies, considered that our treatment of their wells with acid did the wells some good, and they were willing to take another dose of the same acid.

I have examined the statements of the Malcolm Oil Company and the G-Lee-P Company. The Malcolm Oil Company's statements bearing the dates July 24 and 29 and August 4 and 11 and October 7 and 11, 1932, and the

G-Lee-P Oil Company's statements bearing the dates of August 7 and 13 and September 13, 1932. And each of these statements has appearing opposite it the notation "no charge." We obviously gave these companies a free treatment, but I do not remember giving the Malcolm Oil Company that free treatment.

The Court: What is the earliest date of a complaint that you can fix with certainty out of all of those? A. Well, I can't say. It would be around the 1st of July.

The Court: I don't find anything that fixes a date earlier than October, or at least late in September now, but if there is anything here I would like to have my attention called to it. A. Well, our complaints didn't come in until they put the wells to pumping, see?

The Court: But that is what I was thinking. I was asking when you got these complaints. They seemed to come in, as I get it, early in September or early in October or late in September, quite a bunch. A. Well, I think that would be about right. You see, the wells would flow after an acid treatment, they started off to flow, most of these wells.

The Court: You were treating them along through the summer there. I don't want to get a wrong conclusion about it. A. They would never discover that there was anything wrong with the tubing until they wanted to put them to pumping, with the walking bar.

The Court: I will let you know, all of you, what is running through my mind. It is a mean thought, maybe, that I have, but I got to watch for all of these things. I was wondering if those letters sent out by Dow calling attention to the patent, whether that had anything to do with it, that they had just got, and claiming to the oil treaters like you—I haven't had any proper proof of it yet, but rather hearsay proof—but they went to the people that had the wells at the same time, and I can just imagine every fellow that would go out and look at his old pipe would maybe stick you for an oil pipe that would be pretty near wore out when you treated it. I am wondering, did

you know of these things? A. That wouldn't be true, because they don't have that kind of men in the oil business.

The Court: I have had some here that were pretty—one side must have been wrong in some of my cases. A. In one instance I just mentioned, the Gordon Oil Company, under Atha, well, he took me out of—this was all new tubing when it was run in at that time.

The Court: That is one thing I wanted to know about. A. Oh, yes; that field was all equipped with new material, practically all new tubing; they had run new tubing through.

Practically all of the oil producers in the Michigan field used new tubing, because that is one of the main strings of pipe, and they were getting nice wells. They had no tubing that they had used over and over. They do use the casing pipe over and over if the well plays out. These wells that we were treating in Michigan were new wells. Practically all of them were new wells and had only been drilled in for a short time. These wells were down to small amounts of production. Some wells that we treated were dry holes and we made oil wells out of them. They had not been producing before we treated them.

You do not get enough wells so that you put a tubing down in pretty nearly every one you drill. I haven't found it so in the last few years, as I haven't drilled an oil well in that time. They have all been dry holes.

The tubing of the Gordon Oil Company's well was a new string of tubing. It was in for some time after the treatment, because at first the well flowed. The well started to flow and they thought they were not getting as much oil as they would if they put the well to pumping, so they ran the rods into the well and put the well to pumping, but they could not make it pump. Then they pulled the tubing and finally the working barrel. I know that this was a new string of tubing because I saw it and you can tell by the looks of it. I went out to the well and looked at the tubing and you could still see the paint marks on it, the figures of the length of the tubing, etc. I saw the tubing just a few days, two or three days, before we made the settle-

ment. This was a new well and had only been in for about two or three days before we treated it. It was practically a dry hole and they had to haul oil out to treat this well with. The well didn't make any oil and they didn't get any oil out of this well. On this particular string of well tubing I saw the effects of the acid on the tubing in between the threads and in between the joints. The tubing had been unjointed and the last few joints on the bottom of the tubing were pitted on the inside.

The Court: The same as the other witness told about? The same well? A. No, he didn't see this well. The working barrel in an oil well is turned out in the inside, turned a perfect size. It was badly pitted. It wouldn't be right to put it back in.

The Court: How much did you see it had been pitted? A. Oh, just so it was rough on the inside.

Q. How many feet? A. Of the working barrel?

The Court: How many feet that you saw? A. Just the bottom four or five joints.

The Court: How long was that? A. About 28. Varies from 22 to 28 feet per joint.

The Court: It would come within 100 feet? A. Yes, it would.

The Court: You say that it was pitted on the outside? A. No, I say, the tubing is a little bit rough anyway there.

The Court: Do you think that it would pit on the outside? A. It would,—if there was acid on it, you mean?

The well was acidized by putting the acid down the inside of the tubing, and to prevent the acid from coming right up on the outside of the tubing, the well hole was filled with oil outside of the tubing, then pressure was put on the oil. I cannot say how far up on the outside of the tubing the acid came. We carried a pressure on the outside of the tubing with the hole filled with oil to keep the acid from coming up on the outside of the tubing and to shove the acid back into the formation. The acid will probably come up around the outside of the tubing for a little ways, probably to the extent of three or four joints of

tubing, that would be about 100 feet, probably. I think that the acid could come up 100 feet on the outside of the tubing. I know that the acid had come up 100 feet on the outside from the way that it was eaten around the joints. The tubing is a little bit rough on the outside anyway, that is it is rougher on the outside than on the inside. This would not prevent corrosion. The tubing was probably corroded on the outside, but we didn't pay any attention to that. It is naturally rougher anyway. It is not a smooth surface. It would not be easy to tell whether it had been pitted on the outside from acid or not. On this tubing of the Gordon Oil Company the threads of the tubing had been eaten, and that was the only real serious damage. The threads of this tubing were pitted and that was the big thing, that was the serious thing with these threads.

The Court: I am going to want in each case where there is a complaint, the date when the well was treated—that is, if I can get it—the date when the well was treated, and the date when the complaint was made; as well as the date when they settled it, or did something, or something happened about it, if I can get it. I just thought that might help you as you are going along, rather than waiting until after the witness was excused, but I did want those three things.

Mr. Conner: I hope that Your Honor will not hold us to such exact proofs, in that sequence, because this was a small company, and they have been out of business for eight or nine years.

The Court: I am not, but I am just letting you know that I would like to have that, I am letting you know that as you go along, so if you see a place to put it in, you may.

Mr. Conner: We will try to do that.

The Court: I thought it was better to tell you now than to wait until your witness had gone, and then say what I would like to have you do.

The Witness: I have examined the entries appearing on page 3 of our ledger book under the heading of Stork Oil Company. We had some trouble with respect to cor-

roding the tubing of the Stork Oil Company and we made a settlement, but I do not recall the details. The notations under the Stork Oil Company appearing in our ledger book says "October 31, 1932, pipe damaged, $121.50. This appears on page 3 of the ledger book under the heading of the Stork Oil Company.

On page 5 of our ledger book, under the heading of Columbia Oil & Gas Company, I find an entry under the date of September 20, 1932, and an entry for October 17, 1932, and opposite each of those dates I find a notation "no charge."

The date appearing in this book opposite the Stork Oil Company to my mind does not indicate the date when we made the adjustment and came to an agreement, or the date when damage was done to an oil well belonging to this company. The dates here given are the dates that we gave a free treatment to these companies. We gave a free treatment for some damage that had been done previously. There is nothing in this ledger book to indicate the well the free treatment was given to, or what well had been previously damaged. It might be that the free treatment was given to the same well previously damaged. The entry says that 1000 gallons of acid was used in the free treatment. The entry for October 26, 1932, says that 1000 gallons of acid was used, and that 1000 gallons of acid was used in the treatments for September 20 and October 17.

On page 31 of this ledger book, under the account carried for Cliff Warner, I find the notation "No charge, for $130.00" and a second notation "No charge" appearing under the date of October 8, 1932. There is no date for the first notation. This ledger book has been in my files at Mt. Pleasant, Michigan, in the office of Dougherty and Markey. It has been in my possession. I do not know who made these entries. One of the bookkeepers, I think, made them when we started keeping these books at Mr. Lee's office in Midland. The books were there when we first started in business.

This ledger book shows the extent, so far as it goes, of the business done by the Oil Makers.

At this point the ledger book of the Oil Makers Company, was offered and received in evidence as PX-213.

The Witness: A copy of a statement made to the G-Lee-P Oil Company under the date of September 11, 1932, carried the notation "One shot, no charge." This is a statement made to the G-Lee-P Company by the Oil Makers Company or a copy of a statement. It does not, however, have on it the name of the Oil Makers Company, but I have no doubt but what it is a copy of the statement rendered to the G-Lee-P Company.

At this point the statement rendered to the G-Lee-P Oil Company was offered and received in evidence as PX-214.

The Witness: This is not a bill for damages. It is a statement of accounts due with the notation "No charge" on it, which was rendered to the G-Lee-P Oil Company, which operates in the Greendale field of Michigan.

Another statement is made out to R. C. Malcolm Oil. This statement shows accounts due the Oil Makers Company, and opposite the dates of October 7 and October 11 appear the notation "One shot" followed by the notation "No charge."

At this point the statement to R. C. Malcolm was offered and received in evidence as PX-215.

There is no date showing the year on this statement to R. C. Malcolm but I am sure that it would be 1932 or 1933. We continued in business about a year, a little over a year. We always managed to get a check for the treatment we had already made, and then when making a settlement we gave a free treatment. I do not remember when it was the other way around. There were several times when we had to take money out of other of our concerns to keep the Oil Makers Company going, and put it over into this venture. Mr. Markey and I were in the oil business and Mr. Lee was in the business with us and he used his trucks to haul the acid. So we could take money out of Dougherty and Markey and nobody but ourselves was involved.

I received a notice from The Dow Chemical Company

calling attention to their patent No. 1,877,504. This notice of this patent was received in the form of a letter. I have the letter here before me and it is marked PX-199, and the letter is dated September 23, 1932.

My associates did some acid work in Texas. Mr. Edgar Lee was doing that work in Texas. I treated the first well that was treated in Texas for Pitzer and West. I did this work myself for Pitzer and West, who later formed the Chemical Process Company. I treated the first well that was treated in Texas for Pitzer and West. I made this treatment in the latter part of June, 1932, and I used hydrochloric acid which came out from Fort Worth, from a chemical company in Fort Worth, but I cannot recall the name of the company now. This was hydrochloric acid and it was raw hydrochloric acid.

CROSS EXAMINATION

I cannot recall or give you the approximate date of the last acid treatment that was performed by our company before we went out of business. The last treatment was in Louisiana and Mr. Lee was there at that time, and I wasn't paying much attention to it. I cannot give you the date of the last treatment that we made in Michigan, nor can I tell you the name of the well that we last treated in Michigan, we treated so many of them. I would rather think that the last date of a well that we treated in Michigan would appear in our ledger, which is marked PX-213. I am not positive of that. I cannot tell you whether or not our ledger contains a record of each and every treatment that was performed by our company or by our partnership in the State of Michigan. I do not know whether the ledger contains this complete data or not. I did not pay much attention to the book, the ledger.

This company was a side issue with me. I never had occasion to have these books audited or checked, and I could not swear that they were kept correctly. I made no money out of this company called the Oil Makers. I think

that Mr. Markey and I each put in $200.00 and Edgar Lee furnished the truck. Our capital to start was $400.00. I did not get any money back, I lost. I never got any money back out of this venture.

I received no salary and spent a lot of money. I spent quite a lot of money. We did not go through a court in bankruptcy. We got out of business by just paying off our debts. That is all. We did not come out exactly even, we had to take money out of our pockets to get settled up. We each put in $200.00 to start with and I think we had to put in $700.00, if I am not mistaken, to wind up the business. I mean that Dougherty and Markey put in $700.00 to wind up the business. Mr. Markey and myself did not draw a salary, but Mr. Lee drew a salary of $250.00 a month plus expenses, I believe it was something like that.

We were not the first ones in Michigan to offer this acidizing as a service to the oil industry. We were drilling some wells out in the Greendale Pool of Michigan when The Dow Chemical Company and the Pure Oil Company started to experiment on some Pure Oil Company wells using acid. I think The Dow Chemical Company first went into this acidizing business offering this service to the different oil companies. I think The Dow Chemical Company had already gone into this business before we started.

I know the G-Lee-P Oil Company very well. I drilled some wells for them. Mr. Lee, who is here in the court room, is one of that company. The Oil Makers Company acidized the first well for the G-Lee-P Oil Company. I believe that I am mistaken. Upon consideration of the article appearing in the Midland, Michigan, "Midland Reporter" under the date June 9, 1932, reading "Since the commercial use of the acid was decided upon, the G-Lee-P firm has been the first to contract for its use, according to Laurence W. Lee, an official; one well is being treated, while 6 more are to be given acid in an attempt to bolster production." This is not work that the Oil Makers Company did. I believe I am mistaken in stating that the Oil Makers treated the first well for the G-Lee-P Company. I think that the G-Lee-P

Company did have Dow treat the first well up there for them. I am quite sure of that now.

The first time that any representative of The Dow Chemical Company ever talked to me about this subject, or examined my records that I have produced here, was about a week ago Sunday, I believe. First they called me over the telephone two or three nights previous to that, and that was the first time they contacted me. That was the first time I had any communication or any contact of any kind with anybody of the Dow Chemical Company regarding this case.

Mr. Lyon: I am not talking about this case, but I am talking about your experiences in 1932 in acidizing wells? A. Well, we had a lot of discussion, yes, at the time we were treating wells. Do you mean back at that time?

Q. Was there any discussion at that time about these settlements that you made for damages—or, for damage to wells? A. With a Dow official, you mean?

Q. I don't know anything about officials; with anybody in the Dow Company; did you have any discussions with them about it? A. I don't recall. I believe I did get in a discussion with Bob Quinlan. He was with the Dow Chemical Company at that time. That was in Muskegon.

Q. As a matter of fact, Mr. Dougherty, didn't the Dow Company advise you, or some representative of theirs advise you, or your associates, to make some of these settlements? A. Oh, no.

Q. They did not? A. Oh, no.

Q. You didn't discuss it with them at the time? A. We didn't discuss anything with Dow at that time.

The Court: I think you interrupted him. He was about to tell us something about Bob Quinlan and what conversation he had with him. A. That was pertaining to this inhibitor, that we were infringing on the Dow patent.

The Court: When was that? A. That was about in August of 1932.

The Court: Well, what did he say about it? A. That

we were infringing on the Dow patent and we would be shut off, we would be stopped.

The Court: Now, I call your attention to the fact that the Dow patent did not issue until September 13, 1932, and if you are right as to his saying they had the patent I was wondering if it was not later than that, or whether he said they had a patent or going to have. I just call your attention to that, because I can see you are trying to tell me the way it was and all that. A. We heard that right from the start, that Dow had applied for a patent or had one, and was going to stop us from using this acid to treat wells.

The Court: Acid to treat wells? A. Yes.

The Court: Even raw acid? A. Well, yes, even raw acid at that time, because there was an appliance of putting it in under pressure and they had that patented, and all that.

Mr. Lyon: In that connection, so the court will understand the situation while this witness is on the stand, I am going to read a copy of a memorandum dated August 20, 1932, which was produced by the plaintiff in response to our subpoena. This is a memorandum addressed to Mr. L. I. Doan of the Dow Company by Thomas Griswold, Junior, who was one of Dow's patent attorneys. It is dated August 20, 1932, and the subject is "Treating wells."

Reading: "We have had the records in our Dowell acid patent application critically reviewed by Dr. Veazey, with the thought that his experience in patent litigation would be of value, and he has approved the record to date. He makes the following suggestions:

"A. All men in touch with the field to be on the alert to detect infringement, determine who is infringing, who sold the acid, date, what it was to be used for, dates, names, and addresses of all persons acting or having knowledge.

"B. Be on the alert to detect the case of a well injured by the use of acid without the inhibitor. Such an instance would afford very valuable evidence in sustaining the patent. Written reports should be made in all cases to the patent department," and so forth.

Mr. Lyon: Now, I would like to know, what I am trying to find out from the witness is the settlements that were made, of course, the settlements are settlements, and they are not binding on the defendant in this case. The question is how much probative value they have. I want to know if he had any contact with the Dow people at all at that time, and if not how long was it after that before the Dow people came around and asked to examine these records, or learn about these facts? A. They never came to examine our records, and I never talked to any of them pertaining to damage we done on any wells. What right did they have to come and examine our records?

The Court: Whether they talked to people or not, you don't know one way or the other. A. I don't know.

I do not recall whether I talked about this subject or not with anybody before the representatives of The Dow Chemical Company called me up about a week and one-half ago. There is Mr. L. W. Lee, that is one of the officials of The Dow Chemical Company. He is also in this G-Lee-P Oil Company, for whom we contracted and drilled wells. Perhaps it has been talked over between us, but I do not know. Mr. L. W. Lee, one of the officials of the Dow Co., is a brother of Edgar Lee, my partner in the Oil Makers Co. I do not know to what extent Mr. L. W. Lee may have had knowledge of these transactions as to the date they occurred, or since.

Mr. Owen: I would like to call attention to the fact that there is no testimony that Mr. L. W. Lee is an official of the Dow Company. That is not a fact. He is an employee of Dowell, not an official.

The Court: You can state right on the record now what his connection is.

Mr. Conner: Mr. L. W. Lee is an assistant manager for Dowell Incorporated. He is not an officer of Dowell Incorporated and he is not an officer of The Dow Chemical Company. So far as I know he doesn't work for The Dow Chemical Company. He works for Dowell. That is his present connection, but he did formerly work for The Dow Chemical Company.

The Witness: On several occasions I personally negotiated these various settlements resulting in the giving of free jobs and the payment of money on these claims of damage to the well tubing, and on several occasions my partner made these settlements. I think that in each case I was consulted.

After September 1st, 1932, we had some complaints and claims in Texas concerning damage to either equipment or pipe resulting from our acidizing services. Those I do not know anything about. I do not recall any complaints in Oklahoma. We did have some complaints and claims of damages arising from the use of acid which we obtained from the Grasselli Chemical Company. I think there were some claims of damages when we were using this acid. I cannot tell you which of these claims arose from using the Grasselli Chemical Company's acid. I do not remember anything about it. But it is my understanding that we did have some claims arising from the use of the Grasselli acid. I do not remember whether we settled these claims for damages or not. I was in Texas at the time. I do not recall now of any claims that were made against Dowell Incorporated, claiming that the acid sold by them injured the well tubing or pipe.

Q. (By Mr. Lyon): Well, are you sure that there were no claims made against you or your company, or demands for damages or free jobs on the basis of injury to the pipe from the acid that you employed here in Michigan after you started using the Grasselli acid? A. I don't recall that there was any claims.

Q. Do you recall that there was not? A. No, I couldn't say either way.

Q. There may have been? A. There might have been.

The Witness: I believe that the ledger, PX-213, contains a record of each and every acidizing job that I or my associates performed in the State of Michigan after the formation of the Oil Makers Company.

On page 65 of the ledger book, under the account with the Grasselli Company, appears an item dated September

21, 1932, regarding receipt of a car of acid costing $456.57. I do not know whether or not that is the first car of acid received from the Grasselli Chemical Company. It could not be the first car received from the Grasselli Chemical Company. I think that we had acid shipped into Midland from the Grasselli Chemical Company before that.

All of the acid that we received from the Grasselli Chemical Company did not come to us in railroad tank cars; I think that we sent trucks to Cleveland several times to obtain acid. This, I believe, was done in between times when we were short of acid. That is, we would run out of acid and send a truck down, in between times to get acid; the railway cars wouldn't get in so we would send the trucks through.

The Court: It ran up as if you was getting it in Detroit without any difficulty through August and through September, as I glance at it.

Mr. Conner: Yes.

The Court: And then there seems to be a breaking off which made me wonder if you didn't get a few loads by truck, and then maybe your first carload the one you had there, but I don't know. Nobody seems to be able to lead you, so don't let us. A. What is the first check?

The Court (interposing): You are doing pretty good, if he did get that from down there, and had a few truck loads, and then September 19th a carload.

Mr. Owen: Probably if they went over in the truck they paid cash for it, so it wouldn't be by check.

Mr. Lyon: Your Honor please, the witness has asked me for the record of the date of the first check in payment to Grasselli which is recorded here on page 65, which is the Grasselli account. I am calling the witness's attention that the first check is under date of September 19, check 46, $475. A. That is probably the first.

The Court: But maybe not. Don't let me or anybody else, witness, convince you against your best memory about it.

The Witness: It looks as if each customer of the Oil Makers Company and their dealings with this company are

recorded on a separate page of PX-213. This is the first time, I believe, that I have looked over this book. I do not know much about it. In this ledger appear charges made to the customer in the lefthand column, and here is a record of the payments made by the customers in the righthand column. Something has been left off here, I don't know what the reason for that is. According to the record in the ledger, under the heading of the account with the McClanahan Oil & Gas Company, the first acid treatment noted on this account was not the first treatment we made for this company. Page 1 of this book, carrying the account of the McClanahan Oil & Gas Company, shows that according to this book we made fifteen treatments for that company. Practically all of these treatments were successful. I don't recall of any complaints of any kind that we have had from this company. The big majority of these fifteen treatments made by the Oil Makers Company for the McClanahan Oil & Gas Company were made with raw acid.

The next account is that of the Stork Oil Company, for whom the Oil Makers treated three or four wells. I think that all of these acid treatments were successful. I think we made three treatments for them and gave them one free treatment. It would seem that we were using Grasselli acid in treating these wells for the Stork Oil Company.

There is a period in here as to which I am not sure whether we were using the acid from the Pennsylvania Salt Manufacturing Company or from the Grasselli Chemical Company. There is a sort of overlapping period. I want to correct my previous testimony regarding the account of the McClanahan Oil & Gas Company. We treated about fifteen wells, according to this book or record for this company, and the first nine wells that we treated for them we used raw acid from the Pennsylvania Salt Manufacturing Company and the last six wells we treated for them we probably used acid from the Grasselli Chemical Company. The chances are that these last six wells we treated for the McClanahan Oil & Gas Company were treated with Grasselli acid.

According to the ledger, the last treatment for McClanahan was November 30, 1932. I do not recall whether that date is correct or not. According to the record that is correct, but I do not know whether that is the last well we treated for them or not. I do not recall any later treatments than that. We got paid for all of these wells treated for the McClanahan Oil & Gas Company, but we were not particularly careful in keeping our book. I know of my own knowledge that all of these wells we treated for the McClanahan Oil & Gas Company were paid for.

The next account in the ledger book of the Oil Makers Company, PX-213, appears on page 3 of that book and is the account of the Stork Oil Company. We got paid for all of the acid treatments for this company. I do not remember the credit we apparently extended this company on their No. 13 well, involving the item of $121.50. There is a man here that will probably remember it when you get him on the stand. I don't remember it.

The next account appears on page 5 of the ledger book under the heading Columbia Oil & Gas Company.

Q. Will you tell us how many treatments the book shows for this company with what you believe to be the Penn Salt acid, and then how many with the Grasselli acid? A. That would be about the same. About up to the first of November.

The Court: There is October, and I just want to call your attention to it so you will classify it the way you think you ought to there. A. Columbia Oil & Gas. There are about seven or eight shots of Penn Salt.

Q. And how many of those do you believe were successful jobs? A. Columbia Oil & Gas? I am not sure whether we gave them a free shot there.

Practically all of these treatments were successful treatments in that we increased the production of the well. There were two or three jobs that we did for the Columbia Oil & Gas Company where we ruined a working barrel and a few joints of tubing. There were two or three treatments where we did damage to wells belonging to the Columbia

Oil & Gas Company. I just don't recall now, but I remember that we made a settlement with them. It says here in the ledger book "credit of $175.00." That settlement was made September 30, 1932. I have a personal knowledge and recollection of the details of those difficulties with the superintendent of the Columbia Oil & Gas Company. The trouble was that we left the acid in the well too long, or something. At different times we didn't have the best pumps in the world. A pump would break down or something and we didn't get enough oil in behind the acid.

Q. (By Mr. Lyon): Well, in other words, you were just starting in in this business in June, 1932, and it was something new and you didn't have the best equipment and you naturally had some discrepancies and difficulties at that time? A. Everybody was having trouble at that time.

Q. Was Dow having trouble? A. Every one of us.

Q. They were having troubles of the same kind? A. Sure.

Mr. Wiles: Of course, that is pretty bad hearsay, unless the witness knows.

Mr. Lyon: The witness is answering.

The Court: I will let him answer. But I will ask him, how do you know they were having trouble? A. Hearsay.

The Court: Yes, but who told you? Did you get it back through that Lee and his brother that was with you? A. I imagine so. I don't recall now.

The Court: Maybe that communication works both ways, you see.

Mr. Owen: Maybe.

The Court: Only I recognize a difference. You have supplied the witness at the other end of a telephone line.

Mr. Wiles: Sure.

The Court: And they haven't. All right.

The next account in our ledger book, PX-213, appears on page 7 and is that of the Tolbert Oil Company. I see a pencil notation on this page reading "To be paid by Dougherty and Markey." I don't know what that means or what was to be paid. I do not remember this. Dougherty.

was myself and Markey was my partner. I remember the Tolbert Oil Company. There were three acid treating jobs done for the Tolbert Oil Company using acid from the Pennsylvania Salt Manufacturing Company. All of these treatments were successful. I do not recall any pipe trouble or any corrosion on any of these jobs. After October 18, 1932, we treated five wells for the Tolbert Oil Company using acid that came from the Grasselli Company, I imagine.

The next account in our ledger book appears on page 9 under the heading James & Voorhees, and shows that one acid treatment was made on August 24, 1932, for this company. I believe that this job would have been done with acid that came from the Pennsylvania Salt Manufacturing Company. And then another job was done for this company on October 10th and another job on October 24, 1932. The acid that was put into these last two wells may have been acid from either the Pennsylvania Salt Manufacturing Company or from the Grasselli Chemical Company. These acid treating jobs were successful. I do not recall any claim or trouble with respect to damaged well tubing, or any complaints in connection with these jobs.

The next account occurring in our ledger book, PX-213, is that of the Peerless Oil Company. I remember this company. Our accounts show that on August 30, 1932, we treated one of their wells using 1000 gallons of acid. I believe that this well was treated with uninhibited acid from the Pennsylvania Salt Manufacturing Company. On September 28, 1932, we treated another well for this company using 1000 gallons of acid and I believe that this acid also would have come from the Pennsylvania Salt Manufacturing Company. On October 23, 1932, we treated a third well for this company using 1000 gallons. The acid used in this treatment more probably came from the Grasselli Chemical Company. Our accounts show that all three of these acid treating jobs were paid for. There was no claim of any refunds or damages to any pipe on these three jobs as I recall.

The next account in our ledger book, PX-213, appears

on page 13 and is the account of John Arthur, Inc., of Mt. Pleasant, Michigan. This account shows that on October 1, 1932, we treated a well with 1000 gallons of acid, and that on October 5th we treated a well with an amount of acid unstated here. These wells may have been treated with either Pennsylvania Salt acid or with Grasselli acid. I do not recall any trouble in connection with these wells.

The next account appearing in our ledger book, PX-213, is the account of the Gordon Oil Company. This account appears to be pretty well scratched up. I cannot account for the state of the writing in this account. I do not know much about this thing. The account for the Gordon Oil Company shows that on October 4th we treated a well with 1000 gallons of acid and charged $175.00. Then on October 4th we treated three wells in Kentucky. This is the same Gordon Oil Company of Mt. Pleasant, Michigan, who presented us with the bill for $175.00, PX-209, and to whom we paid $175.00 by the check dated October 9, 1932, PX-210. I cannot, by looking at this account, point out the particular treatment and the date of the treatment on which the damage is said to have occurred or claimed to have occurred, and in accordance with which we paid them $175.00. I cannot find under the account of the Gordon Oil Company any record of a treatment or transaction corresponding to what is reported to be reflected in these Exhibits PX-209 and PX-210. I cannot find that in this book. The first item under the account of the Gordon Oil Company appearing in our ledger book, PX-213, carries the date of October 4. I do not know who wrote these entries in this book. They are not correct because we treated one well for the Gordon Oil Company on the Taulker lease, and that is where I went out to look at the tubing, but that is not on here at all. I do not know the date of that treatment. It does not look to me as if anybody has been altering or erasing this book, or changing the account of this Gordon Oil Company. Only just here where they wrote the names of the leases down and somebody had got it wrong here. They wrote in here in pencil the leases. They

haven't even got the Taulker lease on here at all. I suppose that this girl here that used to work for Ed Lee did this writing and kept these books. I do not have a well history or log for each of these wells here in addition to what appears in this book. I did not keep a well log or well history of these wells.

The G-Lee-P Oil Company were in the business of producing oil. They were one of our customers.

The Court: What is your best memory as to how many wells you treated with that raw acid you got from the Pennsylvania Salt Company? **A.** Oh, I would say probably thirty-five or forty.

The Court: Now, I want to call your attention, it is hardly fair to mention them, and it wouldn't be if I didn't tell you that I checked it while listening with both ears to the testimony, but if I have added it right you paid this company (Pennsylvania Salt Manufacturing Company) down there $1220.94, and somebody has told me that that acid was .067 a gallon. And then if I divided right that would make 18,276 gallons, and I multiplied it by 2 because I diluted down to the 15 per cent. That makes 36,552 gallons. And then I divided by 500 because the previous witness said that with this raw acid they usually used only 500 gallons. I haven't asked you that yet. And that would make 71 wells. I have given you all of my figures, so some of you can check those, and I would rather be shown wrong than to take the time to re-check them here.

Mr. Owen: I think most of the treatments that this witness has referred to in the book here were 1,000 gallon treatments.

The Court: Well, with this raw acid?

Mr. Owen: Most of them.

Witness (continuing): Most of the treatments we made we used 1000 gallons of acid. All of the treatments did not use 1000 gallons of acid, there were some treatments made with 500 gallons of acid. We treated the greater percentage of wells using 1000 gallons of acid. I think we did this all the way through whether we were

using raw acid or inhibited acid. I rather think that we advocated using 1000 gallons of acid for each treatment from the very start. We did treat some wells using only 500 gallons of acid, but I don't believe we ever treated any wells using more than 1000 gallons of acid. The treatments appearing under the account of the McClanahan Oil & Gas Company show that most all of these treatments were made using 1000 gallons of acid.

The Court: And your estimate, then, is pretty good. I have made my estimate. I get you up to 35 treatments if I run all 1000; he knows some were 500. That gives you some idea, anyway. I wish somebody would check those figures. It wouldn't surprise me at all if I was away off. I haven't checked a single figure.

The Witness: From a standpoint of increased production to these wells, we had just about as much success and just as good results when we used the acid from the Pennsylvania Salt Manufacturing Company as we did when using the acid from the Grasselli Chemical Company.

Q. (By Mr. Lyon): And how many out of those 36 jobs, how many settlements did you have to make in all? I mean how many times did you have to pay and how many times did you actually give a free job?

The Court: The trouble in answering that now is that he says he hasn't been able to tell how many of them were with the Penn and how many were with the Grasselli acid.

Mr. Lyon: That is right.

The Court: I guess he had that in mind but if he wasn't able to define the difficulties in the first instance as between Grasselli as to the whole, I don't see how he can answer this. He can tell pretty readily where most of the troubles came from. A. All the troubles came from using raw acid.

Q. I understood you had some other trouble. A. As I recall, one instance in Texas where we used inhibited acid.

Mr. Conner: You were speaking about the trouble you had in Texas; did your acid come from Grasselli when you used it in Texas? A. Yes, it must have.

Mr. Lyon: It is a pretty fair statement that the amount of trouble that you had you can, from your knowledge of the business, attribute to the fact that you did not have the best equipment, and that you were new in the business, and did not carry out the acidizing operation as successfully—as efficiently as you might have with more experience and better equipment? A. Well, now that wasn't exactly the trouble either, because of that one instance here of the Gordon Oil Company, we stayed there all afternoon and all night putting that shot in, and we could just start the pumps up and run them about five minutes at a time, until the pressure would crowd it up to 1000 pounds on the tubing.

Q. How long was the acid in contact with the tubing, inside the tubing, on that job, do you know? A. From 10 o'clock in the morning until about 4 the next morning, I think.

Q. Under modern conditions, at the present day, there would not be anything like that, would there? A. Oh, surely, it sure would, because if you get that type of formation, you can't put only so much pressure on your tubing.

Q. Don't they re-circulate the acid out now—isn't that the practice? A. Oh, yes, they would take the acid out, I suppose.

Q. And so if they ran into that condition now they would re-circulate the acid and take it out of the pipe—you know that, don't you? A. Yes.

Q. But you didn't know enough to do that then? A. How do you mean, re-circulate it? Take it out?

Q. Reverse the circulation and take it out, or pump it out, reverse the circulation and take it right out of the well—isn't that the practice? A. Yes.

Mr. Owen: What do you understand by this re-circulation? A. Turning the pressure outside of the tubing and shoving the acid back up the tubing again. This will not take all of the acid out of the well hole.

Q. It wouldn't shorten the time of contact between

the acid and the tubing, would it, this re-circulation process? A. Well, they could probably retch it out so you could—you could today, so that the acid wouldn't be on the tubing for the length of time it used to be.

Q. When you went to put in the next shot it would have to go down in the same tubing, and it has the same obstruction to overcome, doesn't it? A. Yes.

Q. So that taking the entire treatment wouldn't the acid be in contact with the tubing just about as long today as it was when you made that treatment? A. I would think so. It has all got to go back in again.

Q. You would think there wouldn't be very much difference in the time? A. That is right.

Mr. Lyon: Are you familiar with this method, actual use of it that I am talking about? A. Yes, I have seen it done.

At this point there was read to the witness the following from the Halliburton manual:

(Reading): "It has been the practice when a well refused to take acid at a reasonable rate of speed to withdraw the acid and start over again.

"On any job, with or without penetrating acid if not more than 100-150 gal. of acid per hour is being put into the formation, reverse the flow and start in again. This should be done after about one or two hours trial."

Witness (continuing): I understand that method of re-circulation, and it results in pumping the acid out of the pipe. The practice is to use oil to re-circulate or to reverse the circulation, so that the oil comes up underneath the acid and flows or forces the acid out of the pipe.

Mr. Lyon: I don't know whether they save it or start with some fresh acid. They could do either one. A. I was wondering, because oil is so much lighter than acid, as to how they would mix.

This is the modern practice of re-circulation when acid treating an oil well, and I did not do this when treating the Gordon oil well.

The ledger of the Oil Makers Company on page 15,

under the account of the Gordon Oil Company shows no record of any pipe or pump trouble for this company, nor any account of pipe or tubing trouble. There is no record in this book of any claim or refund or of making any refund to this company. I have in mind the instance where we had a claim from the Gordon Oil Company and I was on this job myself. Why it was not put in the book I do not know. I cannot tell you now the date of the job that I have in mind. I think that the job was done before the first job entered in this book. That is October 1, 1932. It was done before that I think. It was about one of the first wells that we treated for the Gordon Oil Company. The first well appearing in this ledger book that we treated for the Gordon Oil Company is dated October 4, 1932. I do not recall the date of the job on which we had trouble. I do not know whether we used acid from the Pennsylvania Salt Manufacturing Company or from Grasselli Chemical Company on the job for the Gordon Oil Company on which we had trouble.

The next account appearing in the ledger book of the Oil Makers Company, PX-213, appears on page 17 and is the account of T. L. McColl, Mt. Pleasant, Michigan. Under this account it shows that on September 27 we treated a well using 1000 gallons of acid. I recall that this treatment was paid for and that it was successful, and that there was no damage done to the well or tubing. When I say no trouble or damage I am talking about trouble or damage to the well tubing or pipe. When I am talking about success of the treatment I am talking about the fact that the acidizing was accomplished successfully so far as what we were aiming to do, namely, to increase the production of the well.

The next account appearing in our ledger book, PX-213, is that of the Michigan Oil & Gas Company of Mt. Pleasant. It appears on page 19. This account shows that we made three treatments for these people without any trouble at all, and that the jobs were done successfully. I recall that the jobs were successful and there was no

trouble. One of these jobs was done early in October, and I cannot say what kind of acid was used on these wells.

The next account appearing in our ledger book, PX-213, is the account of the G-Lee-P Oil Company of Midland, Michigan. We got a check from them for $100.00 and gave them a rebate of $75.00. This account of the G-Lee-P Oil Company of Midland, Michigan, shows that we did a job for them on October 6, using 500 gallons of acid. We also did a job for them on November 4, using 1000 gallons of acid. On this last job there was a $75.00 rebate, so that we gave them back $75.00. The acid treating job on which we gave them a rebate was made with Grasselli acid. There will be another man, I think, that can tell you all about that. He put the acid in the well. The rebate that I am talking about in this case is one where we treated a well for the G-Lee-P Company with acid from the Grasselli Company and we made a rebate of $75.00 to them. That rebate is shown here in our account.

The next account appearing in the ledger book of the Oil Makers Company, PX-213, appears on page 23 and is the account of R. D. Malcolm. It shows that we did three jobs for this company. On October 24 we did a treatment using 1000 gallons of acid and on December 6 we made a treatment using 500 gallons, and on December 7 we also made a 500 gallon treatment for them. All of these jobs were paid for, but we have done more work for this company than appears in this book. We had trouble as a result of treating their wells.

Q. When did you have that? A. About some of the first work we did, I think.

Q. Did you have any trouble with the Grasselli acid, do you know? A. I don't believe we used any Grasselli.

Q. What about this job in December? A. Oh, that must have been—we treated about the first wells we treated for them.

Q. That shows when the company was organized, before the incorporation. A. Might have been.

Q. And therefore it wouldn't be in this book? A. I

believe one of the first wells we treated was for the Malcolm Oil Company.

Q. Did you have to give any adjustment? A. Yes, free shots. Two I think.

Q. Those shots were with the Penn Salt uninhibited acid, the free shots? A. Yes.

Q. And they worked all right? Had no trouble on free shots? A. Yes, there was trouble on two or three of them. I know it was all settled by two free treatments.

Q. And that fixed it up? A. That fixed it up.

Q. Those free treatments were made with the uninhibited Penn Salt acid? A. I think so.

Q. Those were before the incorporation. Now the next account is the one on page 25 which is Nelson & Witt. That also has a lot of scratching and pencil erasures and so forth, like the Gordon account does it not. It doesn't look clean like the other accounts I have called to your attention.

Mr. Conner: I would like to have counsel point out any erasures on there.

Mr. Lyon: Well, the witness can look at it. There seems to be a lot of additions.

The Court: I don't think counsel thinks there has been any tampering with the book. I have no idea of that at all.

Q. It doesn't show that you paid anything to them here, does it? A. I don't know. We will have to go through and see.

Q. This is Nelson & Witt about whom you have testified before? A. Yes.

The first job entered here in this record is August 11 when we treated a well using 500 gallons of acid. The job was successful. That is with respect to increasing production of the well. They were all successful. There was no trouble or damage on this job as I recall. I am quite sure that this job of August 11, 1932, was made using acid from the Pennsylvania Salt Manufacturing Company. There was another treatment made for this company on the same date, August 11, 1932, also using 500 gallons of acid, and

there was not any trouble on this well, as I recall. The next treatment we made for this company was on August 20, 1932, when we used two shots of 1000 gallons of acid each. I do not recall that there was any trouble on this job. And it is my understanding that this well was also treated with uninhibited acid from the Pennsylvania Salt Manufacturing Company. The next treatment made for this company was on August 22, when we used 500 gallons of acid to treat a well, and this acid also came from the Pennsylvania Salt Manufacturing Company, and I do not recall that there was any trouble on this job. The next treatments for this company were made August 31, on which date we made two treatments using 500 gallons of acid each. There was no trouble with these treatments. On August 31 we treated another well for this company using 500 gallons of acid, making a third treatment on that date, and there was no trouble on this treatment that I recall, and the record does not show any trouble on this treatment. I don't recall of any trouble, although this bill that these people presented to me for $60.00 for damage, I don't recall whether it was paid. The next treatment made for these people was on August 27, when we treated two wells using 500 gallons each. There were five wells treated for this company on August 27, in all. I do not recall any trouble on these treatments. I believe that all of the wells treated for this company up to this date of August 27 were treated with acid that came from the Pennsylvania Salt Manufacturing Company. The next entry that I have under this company's account is dated October 8, when we treated a well for them using 500 gallons of acid. I do not remember any trouble with that well.

According to this ledger the last treatment made for this company was on October 15, when we treated a well using 500 gallons of acid. Our total charges to this company, as shown by this account, are $2025.00. It is already totaled here on the account. Someone totaled it, but I did not. Now the payments made by this company to the Oil Makers Company are on August 20, 1932, when they gave

us a check for $270.00. On August 27 they gave us a check for $405.00. On September 21, they gave us a check for $405.00. Someone has entered without a date a further check and the book bears the mark "ask Ed," it says, for $405.00. Maybe Ed has got the check. October 7 they gave us a check for $270.00 and October 15 they gave us another check for $270.00, showing a payment of the full balance of $2025.00. There are no records here on this account of any claim or damages being paid or anything like that. I do not remember any trouble or damages in connection with this company. Mr. Markey was looking into this account, and what that settlement was for I do not recall. I wasn't over at Muskegon where these wells were located, to amount to anything.

The next account appearing in the ledger book of the Oil Makers Company is the one on page 27, and is the account of Witt and Wyant. This account shows that on August 13 we treated a well for them using 500 gallons of acid and I do not recall of any trouble in connection with this treatment. The second job for these people is on the same date when we used 500 gallons of acid. The third treatment we made for these people was on August 31 when we used 500 gallons of acid. In all, during August, we treated four wells for these people, and they were probably all treated with acid from the Pennsylvania Salt Manufacturing Company. I do not recall any trouble that we had in connection with these treatments. Our account ledger shows that these treatments were all paid for in full.

I believe it is correct to state that this ledger book of the Oil Makers Company, PX-213, does not carry any items showing a treatment made in Michigan after the date of December, 1932.

The next account occurring in the ledger book of the Oil Makers Company, PX-213, appears on page 29, and is the account of the Dixie Oil Company. This account shows that on September, 1932, we made a treatment for them, charging $125.00. On October 7 we received by check payment of $125.00. I do not remember any trouble in

connection with this treatment. The Dixie Oil Company was a subsidiary of the Standard Oil Company.

The next account appearing in the ledger book of the Oil Makers Company, PX-213, appears on page 31 and is the account of Cliff-Warner of Muskegon. This account shows we made one treatment for this company, but the date of the treatment does not appear in the book. We were not in shape in the summer of 1932 to be giving away acid jobs in order to get business. The account under Cliff-Warner, the one treatment for this company does not bear any charge for this work. I cannot tell from the record of this company what happened. There is no date showing when this treatment was made, and I do not know what happened there. As to this job which there is no date and no charge in the ledger book, I cannot say whether we did the job or not. Under this account there appears that we made treatments for this company on October 8, 14 and 15, using 500 gallons of acid. There is no charge appearing opposite the job which was on October 8. The acid treatment performed for this company on October 8 could have been made using Grasselli acid. I do not know if it was or not. I have no recollection as to whether there was any trouble in connection with these jobs or not.

The next account appearing in the ledger book of the Oil Makers Company, PX-213, appears on page 33 and is the account of George Davis of Muskegon. This account shows that we treated one well for him in September of 1932, making a charge of $135.00. The account shows that we received by check $66.03. I do not remember this particular job and I cannot explain this account.

The next account in our ledger book appears on page 35, and is the account of T. K. Buzard. This is in the Layton field. His address is Mt. Pleasant, Michigan. I remember this account. I remember the work that was done. There were two acid treatments performed, on October 29 and on November 30. The ledger book does not show any charges made for these treatments, but I remember that these treatments were paid for.

The next account appearing in the ledger book appears on page 37 and is the account of Schuster and White of Kalamazoo, Michigan. The account shows that we did two jobs for these people, on November 11 and November 29, using 1000 gallons of acid for each job. I remember these jobs. We finally got our money from the treatment of the Dennis No. 1 well. We drilled the wells to start with, but this Mr. Bierbacher did not make his payment for the lease and the well, and McClanahan Oil & Gas Company took the lease and well back, and they paid us for the acid treatment. We had trouble getting money on the other treatment, because Schuster was away a good deal to start with.

The last account appearing in the ledger book of the Oil Makers Company is on page 39 and is the account of Mr. Robinson of Mt. Pleasant, Michigan, and shows that we made one treatment for him on December 2, 1932, using 1000 gallons of acid. We did not get our money for this treatment. We have not gotten our money yet for this treatment. We just could not collect. He did not protest the job, however.

The treatments about which I have testified here are the only ones that appear in this book. I think that this ledger book was started and kept by Edgar Lee's bookkeeper at Midland, Michigan. That is the same girl who signed these checks. Afterwards we took these books over to Mt. Pleasant, Michigan, and kept them in our office there. After they were transferred to Mt. Pleasant they were no longer kept. After that most of the work that we did was done in Texas.

The Court: I will say about the books, while I am thinking about it, on the record, that they impress me as being honest, but partial, not complete. They are not kept so that there could be a trial balance taken off. They are not that kind of books. Any fault I have to find with them is that there isn't more of it.

Mr. Lyon: Do you think from your best judgment that this book, PX-213, contains an entry of probably all the jobs that the company did from the time it was incorpor-

ated up until it finished acidizing here in Michigan? A. Perhaps not all of them, no. There were some few after we took the books over, I know.

I think that I took these ledger books from Midland and took them over to Mt. Pleasant, Michigan, some time in December of 1932 or January of 1933, just about that time. After that there was not much work done in Michigan. Most of it was done in Texas. There is nothing in this ledger book about our work in Texas. We have books showing what work we did in Texas. I do not know whether I brought those books with me or not. I have a couple of boxes of them.

Page 65 of the ledger book, PX-213, under the account with the Grasselli Chemical Company shows the following purchases of acid from that company. A car of acid from this company was received on September 21, a second car on September 29, a third car on October 17, a fourth car on October 24, and a fifth car on November 12, all of 1932. These entries show the receipt of acid from the Grasselli Chemical Company, and I imagine all of this acid was used in Michigan. The next entry is for November 17, and in parentheses is "car No. 6." Apparently this acid was also received and used in Michigan. The seventh car of acid from the Grasselli Chemical Company was received December 7 and was used in Michigan. The eighth car of acid from the Grasselli Chemical Company was received December 8 and there is a notation in the ledger book, PX-213, stating Texas. The ninth car from the Grasselli Chemical Company was received December 20 with the notation Louisiana. I believe that the acid for these treatments was received and used in Texas and Louisiana. After the receipt of this ninth car of acid from the Grasselli Chemical Company on December 20, I believe that we received other acid from this company and that it was shipped to Texas and Louisiana.

I did not interest Mr. Pitzer in this acidizing business in Texas. He was not in the acidizing business at that time. He is the gentleman who later started the Chemical Process

Company. What I did was to demonstrate by treating a well for him using uninhibited acid that I bought in Ft. Worth. The acid treatment was very successful and there was no trouble with the pipe. I did not charge him for this acid treatment; it was a free job, that is, a demonstration. I believe that I did previously state that I had not given any free treatments. I did say that, but I didn't have this treatment in mind then. I do not recall that there were any other free treatments that we gave. I think that this was the only free treatment we ever gave. That is, the first free treatment we gave and the only free treatment we gave was when we first went down to Texas to demonstrate this acid treatment to Mr. Pitzer and to get started there. This was the first treatment that we made in Texas and we wanted to know how the acid would work ourselves. This treatment was made in Texas between Breckenridge and Ranger, south of Breckenridge, and we were treating a limestone formation. It was an old well, about 10 or 15 years old. The well was making about 8 barrels, as I recall, and was pumping. As a result of the treatment the well production was increased to 270 barrels, I believe. These wells were all big wells back in the flush days when they were originally drilled in. I would say the well's original production had been around 2000 or 3000 barrels. They were big wells. I think this well was about 3600 feet deep. This free treatment for Mr. Pitzer was made, I believe, in November of 1932. As a result of making this treatment for Mr. Pitzer we made some more jobs in Texas and we sent a man down there. We built storage tanks in Breckenridge and shipped acid from Cleveland, Ohio. I do not recall if we made any more acid treatments for Pitzer. I came back from there.

I do not know anything about the complaint we had in Texas as a result of using Grasselli acid. Mr. Edgar Lee would know about that. All I know about it is what I recollect from talking with him. I don't recall where it was. I do not know what Mr. Lee did about this complaint. The Dow Chemical Company, or rather Dowell, Incorporated, later went down into that field to acidize wells while we

were there. They were competitors of ours, and they were in Louisiana while I was there. The reason that our company was unsuccessful and had to go out of business was that the price of oil went down in Texas and Louisiana. It was just impossible to make collections. No one wanted to treat their wells to increase production when they weren't getting enough money for their oil.

Mr. Lyon: Well, if you had had the resources even mildly comparable to the Dow Company to carry through that kind of a situation is there any reason that you know of why you couldn't have gone ahead with the business and made a success of it? A. Well, yes, there is one reason why we couldn't. We weren't large enough and there were a lot of the small operators that wouldn't allow us to put acid in their wells because they were afraid of the suit against them by The Dow Chemical Company.

Q. Afraid of being sued— A. (Witness interposing) —by The Dow Chemical Company, yes. They wrote letters to every producer in this field, every company we would treat a well for they would get a letter from The Dow Chemical Company, they were liable to suit with us for infringement.

The Witness: I do not recall anything about The Dow Chemical Company notifying our customers that they expected to get a patent some time in August. I do not know anything about this. I remember the letter that I got from The Dow Chemical Company stating that we were infringing.

Q. And you got that letter before you actually had ever used any Grasselli acid, where you had actually acidized a well with Grasselli acid? A. I think so, yes.

Q. Now, this Moline Oil Company that plaintiff says he gave $67 to in settlement of some claim for damage, do you remember that situation? A. I don't recall that is correct. I know I made a settlement with Mr. Wolmer.

The Witness: There is no record in our ledger book, PX-213, about the trouble that we had with the Moline Oil Company. My recollection or my knowledge of this cor-

rosion trouble is from memory. I was not present when this oil well of the Moline Investment Company, on which we damaged the tubing, was treated with acid. I do not recall how long the acid was in the pipe. I did see the tubing that had been injured. It was pretty badly eaten up around the threads. There was several hundred feet of it, the bottom part of the tubing, where the threads were corroded. I do not know what happened by way of settlement, or how we arrived at this figure of $67.00 in making the settlement. I forget now just how that was. My partner was over there doing this work and he got in a mix up with Mr. Wolmer and they couldn't come to a settlement and I went over with him.

Mr. Lyon: Did this $67 represent the full value of it or the full price for that, for the number of sections of pipe that were damaged, the threads that were damaged, or did you just pay some part of that value? A. I might be mistaken on this $67. I might have gotten this by looking this over the other day. I don't know what I did settle with him for.

Q. How much do you think you paid him? A. I know it was a pretty good allowance. He was about to throw us both off his front porch that afternoon.

A lot of these people for whom we were treating wells, and with whom we were dealing, were acquaintances of ours here in the community in Michigan. They were not strangers to us and many of them were people that we were dealing with and had met from time to time. We did not want to get into any arguments with them. We wanted to give them the benefit of any doubt in these settlements and to incur their good will in connection with any further business.

I did not see the tubing that was damaged of this Moline Oil Company before it went into the well, but I think it was new tubing. I do not have any knowledge of the condition of this tubing or how old it was before we acidized the well, but it looked like new tubing. I did not know or understand at the time that we were in this business and

when we were making these settlements, that an inhibited acid would attack rust to just the same extent that raw or uninhibited acid would attack rust. I do not even know that now.

Mr. Lyon: You didn't distinguish in any question of damage to the pipe or even threads or anything like that, between the action of the acid on rust and the action of the acid on good, unrusted metal? A. Well, I knew that it would attack a rusty pipe a lot quicker, but I thought an inhibitor would work on old pipes the same as on new.

Q. Did you think the inhibitor would prevent the acid from acting on rust? Was that your idea at that time? A. Not on rust, no.

Q. I am trying to get at this: Was it your idea that it was safer to run an inhibited acid down a badly rusted pipe than it was a raw acid, at that time? A. No, I didn't—

Q. (Interposing): You thought it would be just as dangerous to run an inhibited acid down as a raw acid? A. Just as dangerous?

Q. Yes? A. Well, I wouldn't say whether or not it was—no, the uninhibited acid would, of course, be more dangerous on any pipe, isn't it?

Q. Well, I am asking you in the case of a rusted pipe, so far as the rust is concerned, what was your understanding? A. Well, they use acid to clean rust from pipe.

Q. That is right, and it will— A. (Interposing): Dip it in.

Q. Does it made any difference whether it is inhibited or not? I don't care what you know now; I am not asking you to testify as an expert now. I am trying to find out what you knew about this business when you were making these settlements? A. Well, I didn't take it in consideration.

I do not know whether the $67.00 paid to the Moline Oil Company represented a full settlement for the full value of the pipe that was corroded. I do recall that there was several hundred feet of tubing spoiled and they had it laid out beside the well.

Q. Do you know the date or the approximate date of the acidizing of the well that that claim arose out of? A. It was early in the fall of 1932. It was a real hot day.

Q. I am sure that I am not reliable on when the fall starts here in Michigan. About what date could it have been, between what days? As near as you can tell us. A. We could tell by the book we just went over.

Q. I didn't think we found any trouble in this Moline camp. A. I can tell you about the time of the treatments of the wells. And those wells would find out about the tubing right away, because they put those back to pumping, and would find out there was something wrong.

Q. That is a fine thing. They didn't even put the Moline Oil Company's name in the index. I have got to go through the whole book. A. Wolmer. Find his name.

Q. No such name in this book. I don't find any account with the Moline Oil Company or Mr. Wolmer in this book.

(Witness speaking to counsel.)

Mr. Lyon: The witness says that he thinks that account isn't in this ledger, PX-213.

The Court: That probably means that it didn't occur during the period that that book covers. A. Oh, yes, it did.

The Court: During that same period? A. It did.

The Court: Well, then, there is some accounts evidently that are not in that book at all. A. Yes.

The Court: If you are right about that. A. That is right.

The Court: I thought—I had hoped we had a book that was fairly complete for the given period, but that it did not start during the partnership, until the corporation, and then it ended with about the year 1932, but now I have got to subtract from some of my good opinion from it, and say that there were accounts and actual transactions of the same kind that weren't reflected in there at all, you think. Is that right? A. Yes.

The Witness: There wasn't much work done by the Oil Makers Company, if any, in Michigan after December

of 1932. The Oil Makers Company stopped its operations in Texas shortly after the bank holiday, which was some time about in February of 1933.

Q. (By Mr. Lyon): Can you tell me something about these ledger sheets? These seem to be just a few sheets out of something, out of somewhere. Is there a ledger book that these came out of? A. Yes, I think there is a lot more of those.

Q. Can't we have the whole book? A. You want me to go and move all those files here?

Q. I don't want you to do that. But you only had about thirty-five accounts. You can't have such a big ledger, so many ledger sheets. A. I did bring over a lot more this morning, when I came.

The Court: You are willing that he see them, aren't you? A. Yes, he can come up and go through the whole thing up there, if he wants to.

Mr. Lyon: I want to do that.

The Court: Well, let me see. It is time to adjourn. It is half past five anyway. You let Mr. Lyon see anything you have got.

Next day—the witness continuing:

At the adjournment last night I delivered to Mr. Lyon, counsel for defendant, four envelopes containing various assortments of papers concerning this Oil Maker Company that I have been testifying about. These envelopes were not in any particular order. I have examined the letter to which you call my attention, dated February 7, 1933, Shreveport, Louisiana, and addressed to the Oil Maker Corporation, Mt. Pleasant, Michigan, and signed Edgar S. Lee. That is the Mr. Lee who was associated with our company and who testified here yesterday. This letter was received by our company in the due course of mail, and I recognize Mr. Lee's signature. The letter starts out with (reading):

"The following is a list of the wells that we have treated under the Coates contract: Paree No. 2, Stile No. 2, Sabine No. 1 and No. 2, Towery No. 1 and No. 2, Hale No.

1. Then there are several paragraphs referring to the financial situation in regard to these wells. This is a report from Mr. Lee, who was down in Louisiana, reporting to our company on the status of the work that our company was doing there. Then there occurs in this letter a paragraph as follows: "The Rotary Oil Company is $100.00 cash and $600.00 to be paid out of one-fourth of the increased production." This refers to the fact that our Oil Maker Corporation was making deals down in Louisiana for acidizing wells and we would get so much cash and so much pay by way of oil as a result of the increased production.

The letter continues and reads as follows: "In treating this well the boys had trouble with their pump, had a high pressure to overcome, and they did not get the acid entirely out of the drill pipe. Consequently this first shot was a failure. We ate up three or four joints of drill pipe, which we will have to replace, and also shoot the well over, which we have already done. As yet we don't know what the increase will be." This well that is referred to in this letter was acidized by our company using Grasselli inhibited acid. I think this is the well I was trying to think of or refer to yesterday.

At this point the letter above referred to was offered and received in evidence as DX-216.

I remember being interested in a company called the Petroleum Investors Corporation a couple of years ago. Mr. Lee was not interested in this company, ut I was interested in this company in the capacity of president. I know William F. Brown.

Mr. Lyon: Mr. Brown testified in this case relative to the acidizing of that well by the Halliburton Oil Well Cementing Company in the name of Petroleum Investors, Inc. To shorten the matter—I will read it at length if there is any question about it—Mr. Brown stated that he was representing the Dow Company and that he was authorized by the Petroleum Investors Company to order that well acidized in the name of the Petroleum Investors Company by the Halliburton Company. Have you any knowledge of that situation at all? A I

Q. Is it true that you authorized Mr. Brown to represent to the Halliburton Company that he was a member of the Petroleum Investors organization and to order that well acidized by the Halliburton Company in the name of the Petroleum Investors Company so as to conceal any interest that the Dow company might have in that transaction? A. Well, as I recall it, I ordered it myself from the Halliburton, Mr. Brown paid the Petroleum Investors and we, in turn, paid the Halliburton.

Q. Why did you authorize Mr. Brown, if he wasn't employed by the Petroleum Investors Company, to use the name of the Petroleum Investors Company in dealing with the Halliburton Company? Did you know that Mr. Brown was acting for the Dow Company? A. I wasn't told definitely but I surmised that he was.

Q. Why did you allow the name of your company to be used on behalf of the Dow Company in that transaction? A. Why did we order the shot?

Q. Why did you allow Mr. Brown to use the name of your company in ordering that acidizing job done by the Halliburton Company if you knew Mr. Brown was bringing that about for the benefit of the Dow Company? A. I don't recall that Mr. Brown ordered the shot. I had Larry King up in the office, went through all the details, and ordered the shot myself. Went through all the details of the oil well treating.

Q. I show you the order to the Halliburton Oil Well Cementing Company, date 4-24-1939, and the name of the Petroleum Investors Incorporated, and it is signed William F. Brown. Is that Mr. Brown's signature, do you know? A. It is.

The Witness: The order to the Halliburton Oil Well Cementing Company dated April 24, 1939, to treat the Petroleum Investors Company's well and signed William F. Brown was not made out before the treatment. I have examined the letter on the stationery of William F. Brown, dated April 19, 1939, addressed to the Petroleum Investors Company, Inc., Dougherty & Markey, Inc., Olympia Build-

ing, Mt. Pleasant, Michigan. These are companies of which I am the president, and the Dougherty and Markey mentioned in this letter are myself and partner. This letter reads as follows:

"Since I am desirous of obtaining certain acid treatment information for a client, and since you are desirous of having a well treated, I agree to pay to you the full charges made by the Acid Treating Company for the treatment of the Knight No. 2 well, located in the southwest quarter of Section 16, Hay Township, Gladwin County, Michigan.

"The conditions which I require are:

"That I choose either Dowell or Halliburton Company to do the work, specify the type of treatment, and be present during the full operations of treatment.

"Also, I shall require average daily production figures for ten days before and ten days after treatment.

"If the above arrangement will be satisfactory to you, please denote your approval below.

"Very truly yours,

"William F. Brown.

"Approved, H. H. Butterfield, for Petroleum Investors, Inc., and Dougherty & Markey, Inc."

I recognize Mr. Brown's signature on this letter. Mr. Butterfield is our secretary. I authorized Mr. Butterfield to approve that letter. I surmised who the client was that Mr. Brown represented. I surmised it was The Dow Chemical Company. I was quite satisfied that it was The Dow Chemical Company. I believe I knew the purpose of this transaction was to obtain evidence for The Dow Chemical Company of the acidizing of the well by Halliburton. I wish to make another statement. Mr. Brown was employed by the Petroleum Investors as a part time geologist, but this transaction was not part of his employment. I understood that Mr. Brown was representing The Dow Chemical Company and that he was reimbursing the Petroleum Investors Company for the amount of money that would be

paid Halliburton for this acidizing job. I didn't understand that, I wasn't told definitely by Mr. Brown, that this was leading to a law suit or anything of that kind, or that he was getting the money from the Dow to do this, but I surmized this because we got a treatment of acid for nothing. Mr. Brown brought over the cash. There was nothing told to me. He didn't even bring over his own check. I surmised there might be some hitch somewhere and I didn't want to be mixed up in it in any way, but I was told nothing about it, any more than that Mr. Brown would pay personally for the acid shot. I am the party who was representing my company in making the original deal with Mr. Brown. I am the only one in my company that made this deal with Mr. Brown. I agree that this deal was one whereby I made an agreement to get this well treated by the Halliburton Company and it wouldn't cost me anything. The rest of the transactions were merely to carry them out in such a way as to have it to look the way they desired it to look.

Mr. Brown called me over the phone and asked if we had any wells that we were planning on treating with acid again, and I told him that there was. We had not used Halliburton or Dow, either one, up to that time. Not at all. We used Mr. Quinlan. He had done most of our acid work. Mr. Brown told me that if I got this particular well ready that he would see that we got a shot of acid free of charge. I asked Mr. Brown just what that was letting me in for, what the mix up was, and he said, "That won't let you in for a thing. I will pay you personally for the acid treatment." I told him to go ahead, and so he made all the arrangements. Mr. Brown asked me to make the arrangements so as to get Halliburton to treat the well. That was the first start of the conversation after he found out that we were planning on treating this well.

The Court: Well how did you know he was interested in the Dow? What is there back of that as far as you were concerned, so that you understood? A. I didn't know.

He doesn't work for the Dow. He has no position with the Dow that I know of.

The Court: You said you surmised it was for the Dow. A. I do.

The Court: Where do you get that idea? A. Because I heard a lot about this suit coming up, and that was for a long time, and I imagined that they had Bill as a go-between—that they had Mr. Brown as a go-between.

Q. (By Mr. Lyon): You have mentioned that this Knight well, which is the one we are talking about, had not been treated before. I wish you would stop to think about that. It is my understanding, although I may be wrong about it, that that well had been acidized before with no increase in production. I don't know by whom. Do you remember? A. Well, we had an increase on all the Knight wells, as I recall.

Q. Do you remember whether this Knight No. 2 well had been acidized before this deal? A. Well, I don't know.

Q. Before you made this deal with Mr. Brown or for Halliburton to acidize it? A. I don't recall whether it was. It came in pretty good.

Q. Do you know what results were obtained by the acidizing of the Knight No. 2 well by Halliburton, pursuant to your arrangement with Mr. Brown? A. It increased the water and both the water and the oil.

Q. You abandoned the well, did you not? A. We have.

Q. The job was not successful? A. Well, I wouldn't lay it to the acid treatment.

Q. Well, the acid treatment did not do you any good, you might put it that way? A. No, not particularly.

Q. And you have abandoned the well? A. We have now.

Q. I mean, how soon, you abandoned it how soon after the well was acidized by Halliburton? A. Probably six months.

Q. But you didn't get any benefit by Halliburton's acidizing the well? A. No.

The Court: Was there any blanket used? A. Yes. We used a blanket.

The Court: Who made the arrangement, now, and decided there would be a blanket used? A. I did.

The Court: No one influenced you in that regard? A. No, no.

The Court: You had a free drink, and did what you wanted? A. Yes.

The Court: By the way, how big a shot did you take?

Mr. Lyon: For your information. Two gallons of blanket and 1500 gallons of Penn acid.

The Court: But you did decide for yourself whether the quantity of acid you would have would be so and so? A. That is right.

The Court: Now, was there any choice of inhibitor, or the percentage of inhibitor that you had in it? A. I don't recall that there was.

The Court: You just decided, all you had to decide then was the quantity of the acid, which was of one kind, and the quantity of the blanket, which was one kind, as I understand the situation? A. I believe that is true.

The Court: You did decide that; Brown didn't have anything to do with deciding that, or Halliburton didn't? A. That is right.

Mr. Wiles: The way they run their operation, they take their storage acid and bring it in the Menaul tank and what it gets on the way is what the customer gets.

The Court: That is the way I understand. Now that was all the kind it was and he got it in that way. There wasn't anything said by you as to how long it would remain in the tank before it was used? A. No.

The Court: Did you know anything about that at that time? A. No, I didn't.

Mr. Conner: I will read the last stipulation that was entered into by Mr. Babcock, at Midland, on Tuesday, April 15, 1941.

(Reading): "Mr. Babcock: Counsel for plaintiff has produced tickets apparently signed by the pumper on the

Knight No. 2 well, Petroleum Investors, Inc., from April 16, 1939, to May 4, 1939, and after a discussion of these tickets between counsel it is stipulated that if this pumper were called, whose name appears to be W. R. Pauley, he would testify that the data on these tickets is correct. And it is further stipulated between counsel that these tickets show that before the well was treated its production was approximately 2.7 barrels per day and that after the well was treated its production was approximately four barrels per day. I request that this stipulation be used in lieu of the one I entered into yesterday."

The Court: Now, that is a nice form of stipulation for both of you to make. It does not tie my hands, or either of your hands, if somebody else is called to get at the facts. However, when they get them, there is nothing that changes that testimony at all, and I am carrying forward the idea now that that increase was about as that witness would say, very small, and that in addition there was enough brine so that the well had to be abandoned.

Q. (By Mr. Lyon, continuing): As I understand it, Your Honor, the run tickets covered the few number of days following the acidizing, commencing on April 16 and running up to May 4, just a short time.

The Court: Can you give us any idea how long that increase continued, or whether it fell off, Mr. Dougherty? A. Well, it gradually fell off.

Q. It gradually went down? A. Yes.

Q. As a matter of fact—you may look at this run, this job ticket on the well, in connection with the acidizing, 85 barrels of oil were pumped into the well, were they not? A. There was.

Q. So those barrels may be responsible for the two barrel increase that evidences itself in the few days following the treatment? A. No, that don't—

Q. Do you not count it in that way? A. We don't count it in that way, until we get the oil back.

Q. I see. A. It is like salting a gold mine, Your Honor. You get your salt back, but sometimes the fellow that owns it thinks he is getting new gold.

The Court: You kept track of the oil? A. We took the oil, kept the oil that was put in one of those sheets for every one of the tanks. The tank was gauged, Your Honor.

The Court: That seems to be a very small amount? A. Yes.

The Court: You generally get better results than you got in that case? A. Yes.

The Court: I take it that there probably was not much water before your treatment? A. No, we weren't getting much water. We just couldn't afford to operate it at a loss.

The Court: Can you give me some idea as to the proportion of brine to oil, your first measurement? I am taking these figures, that there were two barrels a day afterwards. Do you know how much brine you were getting? A. About 50 per cent.

The Court: When does brine become so great that it is impractical to try and save the oil? A. It depends on the size of your oil production.

The Court: Because if you get too much brine, there just isn't anything that you can do with it in the field? A. No.

REDIRECT EXAMINATION

When we treated the well in Texas for Pitzer and West we bought that acid from Houston, Texas. This was raw acid. I believe that this treatment was done some time after we had been using Grasselli acid. This treatment for Pitzer and West was an experimental treatment and we didn't want to go to the expense of shipping or hauling a truck load of acid into Texas all the way from Ohio. That is the reason we did not use the Grasselli acid. We were not getting any pay for this experimental treatment. I recall that the acid went into the formation of the Pitzer and West well in Texas right away with no delay.

I am not positive, but I believe that we had sent trucks to Grasselli two or three times to buy acid in small quantities before we started to purchase it in carload shipments.

This would probably have taken place a week or two before we started to buy it from Grasselli in carloads. Referring to PX-207, check 46, September 19, 1932, for $475.00 would be for a carload. The check dated September 20 and the two checks dated September 23, and made payable to the Grasselli Chemical Company, were in payment for truck loads of acid. I think that these three checks might have been in payment for truck loads of acid purchased from the Grasselli Chemical Company. I do not recall whether any of the Grasselli acid was purchased by truck load prior to the earliest date appearing on these three checks. If such purchases of acid from the Grasselli Chemical Company were made prior to the dates of these three checks, I believe they would have been paid for by check, because we had established credit before we started to buy acid from the Grasselli Chemical Company. That is we had established credit before that time. I didn't look for any stub book. There is a lot more stuff up there.

I have examined Exhibit PX-216, being a letter from Edgar S. Lee to the Oil Makers Corporation dated February 7, 1933, and I note the pen and ink notations thereon. These notations look like our secretary's writing, that is Mr. Butterfield's writing. These notations state "OK on books." That does not mean anything to me.

Mr. Lyon: The papers that were delivered to me did not contain any ledger sheets or any checks or anything else about the business down in Texas or Louisiana, but it contained letters back to the company of every kind and description asking for money, and I think the witness will agree with me that they were in very bad financial position at that time. The men down there were writing for their pay and the Grasselli Company was refusing to ship acid and shipping it on a basis that required payment, and the company was unable to pick up a car of acid after it got down there. There is a whole series of wires about a car you couldn't pick up. A. Yes.

The Court (interposing): We haven't got the books here, but I was just inquiring if you think there was a rec-

ord kept, and, if so, who kept it? A. It was a terribly mixed up affair along at the last.

I do not recall whether or not the Oil Makers Corporation did any advertising other than possibly inserting a notice in the Oil & Gas Journal of June or July of the year 1932.

Mr. Owen: How did your business grow, by what means was it promoted? A. Results.

Q. What kind of results? A. Increase in production.

Q. What is the fact in the oil industry in Michigan about the way news travels about anything that happens in the industry that is of importance or interest? A. It is a very good grapevine.

Q. One operator tells the next one? A. Sure.

Q. And they are in pretty close touch with what others are doing all over the district? A. That is true.

Q. That applies to the different fields in Michigan? A. It does.

Q. They all know each other and they communicate information? A. That is true.

Q. At that time if an oil operator got a substantial increase in production through such a treatment what was his attitude of mind, as communicated to others in the industry? A. Oh, well, when one operator got good results why he was—

The Court: Pretty tickled? A. Why, sure, and everybody else knew about it.

Q. And if he got good results in the way of increased production what would you say about his likelihood of objecting to or overlooking slight damage to his equipment? A. There was a lot of them that did.

The Witness: I identified a letter which was written by The Dow Chemical Company to the Oil Maker Company, which is PX-199. I believe that we received a copy of the patent No. 1,877,504 in connection with that letter. The other operators in the field who were using these acid treatments, other than the treatments given by Dow, were pretty generally notified by Dow regarding this patent.

I recall that I saw some of these other letters other than the letter to our own company. The language in these other letters received by the other companies was practically the same as the language in the letter we received. In the letter that I received it states: "You are respectfully requested to immediately discontinue the use of acid in any manner which would infringe the rights secured to us by the aforesaid patent."

This letter was dated September 23, 1932. At that date I do not know whether or not The Dow Chemical Company knew that we had been using raw acid. I had not told anyone that we were using raw acid.

The Court: Was that brother working with you, or with Dow at that time that he is asking about? A. Lee, do you mean? No, there are two brothers, one in the produce business now, and one with the Dow Company.

The Court: Was one of them with you at that time? A. Yes.

The Court: And the other one was with Dow at that time? A. That is true.

The Court: There was just the same opportunity, but no better and no worse, than there was for that particular grapevine to be working.

In connection with this acid treatment given to the Petroleum Investors Company Knight No. 2 well by the Halliburton Company, as a result of my agreement with Mr. Brown, I called Larry King of the Halliburton Company, and he came up to my office and we talked the treatment over. There were no papers signed at that time when I talked with Larry King. Whatever papers were signed in connection with that treatment were signed at the well. I do not recall that I authorized Mr. William Brown to sign papers for me in connection with that treatment, that is to represent me at the treatment. I do not believe that the Halliburton Company or anybody connected with them knew at that time that the treatment was to be paid for by The Dow Chemical Company, or by anyone other than my own company. I thought that we were getting the regular

treatment, and I did not suppose that Halliburton had anything but one kind of treatment that they were giving.

I had connected with my company either before or after it was incorporated, that is the Oil Makers, a man by the name of Sprenger. His work was that of doing the actual work in the field and he worked for us during July, August and September, I believe, of 1932.

RECROSS EXAMINATION

I have referred before to the fact that 85 barrels of oil were pumped into the Knight well No. 2, which was the well treated by the Halliburton Oil Well Cementing Company in connection with my agreement with Mr. Brown. This amount of oil, 85 barrels, was more than the well tubing in the well would hold. I do not know whether or not the Halliburton representative protested against pumping that oil into the well. The arrangement for pumping that oil into this well was not made in advance at my office. That arrangement was made between Mr. King, the Halliburton man, and the lease superintendent in charge of the Petroleum Investors Company's wells. It is true that the actual details of what was to be done on that well were settled out at the well at the time of the job, and I was not there then. Mr. Brown was then present representing The Dow Chemical Company. Mr. Walter Pauley was present representing the Petroleum Investors Company. I knew what was to be done at the well and what procedures and steps would be taken, as I talked the treatment over with Mr. Pauley, the superintendent of the well. No one decided that 85 barrels of oil must be put in, because no one knew that the well would take that much. In treating a well you fill the well hole with oil both inside and outside the pipe. That is to keep your acid from coming up outside of the tubing. I suppose, in putting that oil in, the 85 barrels, they were trying to fill this hole up, which wouldn't fill up. I do not know whether the Halliburton people made any criticism or any protest about putting this oil into the well

in attempting to fill it up, when the well was taking the oil. I was not at this well at the time of the acid treatment. I heard about the treatment after it had been treated.

I have examined the Halliburton acidizing ticket for this Knight well No. 2, which is signed by W. F. Brown. I identify his signature and this record or ticket is a schedule of the time of operation, and it shows that the acid was in the pipe for 30 minutes on its way going down to the bottom of the well.

Mr. Lyon: How many minutes? A. Well, the acid started in at 5 o'clock, at 5:05 there had been 500 gallons pumped into the well, at 5:10 there had been 1000 gallons pumped into the well, at 5:15 there had been 1500 gallons pumped into the well and that is the end of the acid. At 5:30 there had been 16 barrels of oil circulated. So that it took 15 minutes for the entire amount of acid to get through the pipe on this job. That is for the 1500 gallons of acid, according to this ticket. The oil went into this well first. They put 85 barrels of oil into this well and the 85 barrels did not fill up the well hole.

WALTER SPRENGER,

a witness called by plaintiff, testified as follows:

DIRECT EXAMINATION

I live in Allegan, Michigan, my business is that of building contractor and producer. I have been in that business for myself for 4 years, prior to that I was employed by the G-Lee-P Development Company. I have had no connection with the Oil Maker Company, that is not by that name, but I was associated with the same gentlemen who organized this company. I was connected with the organizers of this company before the company was organized and not afterwards. The gentlemen I refer to are Edgar Lee, Charles Dougherty and Fred Markey, with whom I had a sort of gentlemen's agreement. I was actually in charge of the treatments, and treated the wells.

The arrangement between Mr. Lee, Mr. Dougherty, Mr. Markey and myself was made some time in the latter part of July, 1932, and I continued working with these gentlemen up until about the middle of October, 1932. I was in charge of the well treatments made by this organization during that period. I wouldn't say that I treated all of the wells treated by this organization during that period, but I did treat most of them. The Oil Makers Company was organized some time after the middle of October, 1932, about which date I left this organization. I do not know how much time intervened between the date when I left the organization and the time that company was incorporated.

Mr. Lee would buy the acid and bring it to the field. I do not know whether or not they had any bank account at that date. I did not handle that end of it. When the company was finally organized they called themselves the Oil Makers, but to my knowledge they did not call themselves the Oil Makers during any time while I was with them. I have with me some notes that will help me fix the date when

I first began to treat wells for this organization and when I severed my connections with them.

At this point a book produced by Mr. Sprenger was offered and received in evidence as PX-217.

This book contains other data that does not apply to the Oil Makers and my association with the men I have referred to. The notes in this book were entered at the time that the work was done, and they have been in the book ever since.

At this point four pages of notes from Sprenger's book were offered and received in evidence as PX-218A, B, C and D.

I do not have a record in this book of the first well that I treated. The first record that I have is dated June 22, 1932. This record appears on the page marked PX-218-A. The record under the date of June 22, 1932, refers to the Mooney well No. 2, and indicates that 6 carboys of acid were put into the well with a bailer. 80 barrels of oil were used. This well was treated for Goll-Graves and Meckling. This treatment was made before I made the arrangement with Mr. Lee, Mr. Dougherty and Mr. Markey. I was employed by Goll-Graves and Meckling to do this work. I was regularly employed by Goll-Graves and Meckling at that time and I took care of a lease for them and they had me make this treatment. The acid used came from the Detroit Chemical Company and was delivered to us by truck. I signed the invoices and the bill of lading for the delivery of the acid. Six carboys of acid were used and we put it in the well with a 6 inch bailer. We first took the pumping equipment out of the well and then put the acid into the well with the bailer and lowered it to the bottom of the well, where we dumped it by striking the dump bailer on the bottom of the well. I was told that this was concentrated acid.

Mr. Graves had us treat the well this way and we washed the well down with fresh water and washed our bailer and then we pumped 8 barrels of oil on top of the acid and held it there for 24 hours. My notes do not show

what results we obtained from this treatment, but of my own knowledge I know that this well was producing 5 barrels a day and after the treatment the well made 180 barrels per day. I do not know how long this lasted, but the production gradually tapered off, but it made a commercial producer, and is still producing. I used the acid just as it came to us in carboys. My job was to do the work on this well and I had perhaps two helpers. I didn't make any special charge for this work. I operated these three wells on these two leases and I operated these wells for so much a month. I got $25.00 a well per month. I furnished the pumper and operated the wells for these people. I was doing similar work for other operators. I had a number of wells I was looking after.

At that particular time I took care of six wells for the G-Lee-P Company and one well for Schuller, Wilson and Strange. I think that was all the wells I had charge of at that particular time. I didn't make this bargain to acidize this well or buy the acid. My job was that of taking care of the well and while I was doing that they had this work done and I was there while it was done and worked around with it. I actually did the work. The reason I did this work is because I had treated some wells for the G-Lee-P Company before this. Goll-Graves and Meckling bought the acid and what I did was to put the acid into the well at their instruction. This was not my scheme at all, they figured this out.

I have kept those notes for my private information. The next well that I treated was the Mooney No. 3 on June 29, 1932. Eighteen carboys of acid and 85 barrels of oil were used. This well was treated in the same way as the other well and was treated for Goll-Graves and Meckling. It was one of their wells. We didn't get very good results. We built up a 300 pound pressure on the casing head. That well is still producing. We put in 85 barrels of oil and pumped the pressure up to 300 pounds and let it stand. I don't remember exactly what the results were with respect to increased production, but that well made something less

than 50 barrels after the treatment. Before the treatment it was making just a few barrels. The statement with respect to production is from my memory. The acid used in treating the Mooney No. 3 well came from the Detroit Chemical Company.

During the month of June, 1932, I treated some wells on the Grubb farm for the G-Lee-P Company, but I have no records on this. The records are in their files. These wells were treated before I treated the well for Goll-Graves and Meckling.

The next well that I treated, and on which I have notes, was treated July 24, 1932. I used 1000 gallons of acid, but I do not know of what per cent. The acid came from the Pennsylvania Salt Manufacturing Company of Wyandotte, Michigan, and was received by us in wooden tanks. The acid came to us in Mr. Edgar Lee's trucks. We had one large tank with two compartments in it. The well was named the Hastings No. 1 well and was owned by Wells and Malcolm, and was located in Greendale Township, Michigan, and was the first well I treated after my arrangement with Mr. Lee, Mr. Dougherty and Mr. Markey. I received the acid in the field and put it into the well on this first treatment by pumping the acid down the tubing of the well.

I did not put any money into this organization or company and I did not draw any out. I knew how to handle the acid and knew how to use it and it was built up around that knowledge of mine. My understanding was that if I stayed with these gentlemen I would profit and share alike in the company if it was a success. This was just an oral understanding. I was to do the treating of the wells and Mr. Dougherty and Mr. Markey would furnish the money, while Mr. Lee furnished the transportation for the acid, and if we made any money we were to share equally. The reason I quit this business was because of the losses we sustained.

In treating the Wells and Malcolm Hastings well No. 1 we did not do the well any good and caused a lot of damage by way of damaging the tubing. I saw the tubing. I saw the tubing after the treatment and after the tubing had

been pulled from the well. The bottom part of the tubing was badly eaten around the threads and collars. I do not remember just how far up from the bottom of the tubing that the tubing was eaten. There were several hundred feet of it that had been eaten. I know that a complaint was made by the owners of the well. What the owner of the well told me wouldn't be very permissible here, and they would not allow me to go upon their lease again. I have no record of this damage. In treating this well we put in some oil on top of the acid. The well carried 500 pounds pressure on the casing head and from 250 to 300 pounds on the tubing.

This Hastings well No. 1 treated for Wells and Malcolm was the first well that this organization ever treated. A short time after the treatment my partners, Mr. Dougherty and Mr. Markey, told me that they had made an adjustment with the well owners because of the damage to the tubing.

Mr. Lyon: I move to strike the answer, Your Honor. It is incompetent.

The Court: Who told you and when did they tell you and where were you, and who was present? A. Well, Dougherty and Mr. Markey.

The Court: Anybody else there? A. I don't remember.

The Court: When did they tell you? A. A short time later.

The Court: What did they tell you? A. They told me that they had to pay for that string of tubing.

The Court: Is that all they said? A. I don't remember.

The Court: You don't know how much? A. No, I did not.

The Court: You don't know how long a string of it? A. I don't know what adjustment they made.

The Court: All right.

The next record of a well treatment that I made while working with Mr. Dougherty and these other gentlemen was on July 26, 1932, when I treated the Struble No. 1 well

for the McClanahan Oil & Gas Company. My notes on this well appear in my book on the page that is marked PX-218-B and my record shows that we put 1000 gallons of acid in that well and that we had no pressure on the casing head, and in the tubing we had a vacuum. I put the acid into the well just as it came out to me in the truck. Mr. Lee brought the acid to me. My notations here show that 367 barrels of oil were produced from this well in the first 24 hours after the treatment. I do not know what the production of this well was before treatment. I never heard of any damage done to this well as a result of treating it.

Also on the page of my notes marked PX-218-B I find the next entry regarding these treatments. On July 27, 1932, I treated a well for the Stork Oil Company. I do not have the name or number of the well, but I used 1000 gallons of acid in making this treatment. The casing head had a pressure of 100 to 300 pounds, while the tubing pressure was 100 pounds. This well made 80 barrels of oil the first 10 hours after being treated, but I do not know what its production was before treating. I never heard that any complaint was made about damage to this well from treating it. I do not know how long the acid was in the tubing.

According to my notes the next treatment that I made to a well was on July 30, 1932, when I treated the Root well No. 1 for the McClanahan Oil & Gas Company. I used 1000 gallons of acid in this treatment and no pressure. In these four treatments where we used 1000 gallons of acid we borrowed a pump from the Dixie Oil Company and pumped the acid in through the tubing. I do not know the results of treating the McClanahan's Root No. 1 well. There was no damage resulting from this treatment to my knowledge. There were no complaints. In all the subsequent treatments we pumped the acid in through the tubing.

My notes show that the next well I treated was on August 1, 1932, when I treated the Cole well No. 1 for J. C. Arthurs, using 1000 gallons of acid and no pressure and no oil. I have no records as to the results of this treatment and I never heard of any damage as a result of this treatment.

The next well I treated on August 2, 1932, for the McClanahan Oil & Gas Company. The well was the Morrison No. 2. There was very little pressure and we used 1000 gallons of acid, which was pumped in with a Dixie pump. We used 80 barrels of oil. The majority of these wells were treated on a vacuum after the acid started working. I have no record as to the results of this treatment and I do not remember whether or not any complaint of damage was made as a result of the treatment.

These well treatments that I have been testifying about are treatments that I made and recorded in my personal notes. During this period the organization had no one outside of myself doing this work at the well and I made all of these treatments I am talking about. The treatment of the Morrison well No. 2 for the McClanahan Oil & Gas Company on August 2, 1938, is recorded in my notes on the sheet marked PX-218-B.

Next I treated a well known as the Hastings No. 1 on August 6, 1932, for Wells and Malcolm. I had already treated this well but this was after Mr. Malcolm quieted down a little bit and allowed me to come back and retreat it. After I had treated this well the first time the lease owner wouldn't talk to me or have anything to do with me. Mr. Dougherty and Mr. Markey had made some adjustments with Wells and Malcolm as a result of the first treatment to the Hastings No. 1 well, but what adjustments they made I do not know. So I treated this Hastings well No. 1. They had put new tubing into the well in the meantime. I used 1000 gallons of acid with 50 pounds of pressure on the tubing. I do not remember the result of the treatment. It was a small well. I never heard of any damage being caused by the second treatment. When I treated the well the second time I did not treat it any differently from when I treated it the first time, but in the meantime the well had been shot with glycerine, which opened up and cracked the formation and the formation took the acid the second time. The acid went in much more quickly than it did on the first treatment.

I would go out on these wells and work day and night and sometimes would make these notations later on. Some notations I made at the well and some I made right at my office after I got in.

The date of the next treatment is recorded on the back of PX-218-B, and is dated August 5, 1932, a day earlier than the last treatment I was telling about. This treatment was made for the Stork Oil Company and we treated their Coon well No. 4 using 1000 gallons of acid and no pressure. We used 60 barrels of oil and pumped it in with a Dixie pump. I do not remember the results of this treatment. Some time during this treatment for the Stork Company they made a claim for damage, but this claim for damage was not handled through me. I do not remember whether this claim for damage was in connection with this particular treatment or not. There is nothing in my notes which will show which well they were complaining about.

According to my notes the next treatment I made was August 7, 1932, when I treated the Schaeffer well No. 1 for the G-Lee-P Oil Development Company. I used 1000 gallons of acid. On my notes I have pressure marked here, but there is no mention of the amount of pressure used. Sometimes our gauges would be eaten up during the process of treating and we wouldn't know what it was doing. I don't remember how much pressure was used. Not being a chemist I don't know what kind of acid was used, that is, I don't know what the strength was. I had nothing to do at all with diluting the acid. I used the acid as it came to me in the field. Mr. Lee brought the acid out to me and it would come in his trucks, on which were mounted wooden tanks. The acid always came to me in wooden tanks. I do not have any records here to show the results of treating the Schaeffer well No. 1.

Usually the head man of the oil company told us what strength of acid to use. In the case of the Schaeffer well it would have been Mr. Laurence Lee, president of the G-Lee-P Oil Company. There was very little known about it at that time and that was a pretty slipshod method of

doing it. The man who owned the wells would also tell us how much acid to use. Mr. Dougherty and Mr. Lee would handle most of this part of the business end. It was part of their job. My part of the job was simply to get the acid down into the well.

On this Schaeffer No. 1 well belonging to the G-Lee-P Oil Company I was what is called a "farm boss" and worked for the G-Lee-P Company and had charge of this well. On this well we didn't do it very much good and damaged a considerable amount of tubing. This particular string of pipe was electric weld pipe and the acid ate the weld out and also attacked the collars, threads and working barrel. I saw the tubing myself. We had to replace between 500 and 600 feet of tubing of this well and it was new tubing that we had used only a few days. When we pulled the tubing out of the well it was all split.

Q. Was it split at the weld? A. It was split when we pulled it out of the well.

Q. At the place where it was welded, along the seam? A. Yes.

Q. How badly was it split? So that it was way open? A. No, not like it would be from pressure. Just the weld was eaten out.

The Court: Is there anything about that on here? A. No.

The Court: Well, what is the most important thing about that well from your standpoint? A. What do you mean?

The Court: Well, what is the important thing that happened from the time you went there until you went away from the standpoint of your company or organization? A. We tried to make it produce more oil. It was not a commercial producer as it was. We treated it to make a commercial well of it.

Q. Did you put oil in that well after the acid? A. Seven inches, it shows. That would be about 18 barrels.

Q. That would be seven inches from the tank? A. Yes, in a 500 barrel tank.

Q. And you say that your association replaced the 500 feet of damaged tubing? A. I don't think there was any claim made for tubing. The company replaced it themselves.

Turning to the next page of my notes, marked PX-218-C, they show that the next well I treated was on August 8, 1932, for the Columbia Oil & Gas Company. The well was the Hornick No. 3. I used 500 gallons of acid and no pressure. A Simmerell pump was used to put the acid into the well. We had completely ruined the other pump and could not use it any more, so we borrowed this pump. Eventually we ruined it also. I do not remember the results of treating this Columbia Oil & Gas Company well and I never heard that any damage was done to the well as a result of treating it.

The next well I treated was on August 9, 1932, for the McClanahan Oil & Gas Company. The well was the Schaeffer No. 1, in which I put 1000 gallons of acid. I applied 450 pounds pressure to the tubing and 900 pounds pressure at the casing head using the Simerell Pipe Line Company's pump. This was the second well on which I used this pump. The Schaeffer No. 1 well of McClanahan is about two miles from the G-Lee-P Company's Schaeffer No. 1 well. The Schaeffer well No. 1 produced 80 barrels per day originally. It only did this for a few days and then went right down to almost nothing. After the acid treatment and we got the well fixed up, it pumped its original production again. Both the McClanahan Oil & Gas Company and the G-Lee-P Company have wells named the Schaeffer No. 1. The McClanahan Oil & Gas Company's Schaeffer No. 1 well originally produced 100 barrels and after it was treated it produced 1000 barrels per day.

There was some damage done to the McClanahan Oil & Gas Company's Schaeffer No. 1 well, but I don't think we ever had to make any settlement for this damage. I know there was some damage as I was told about it and I later saw the damage. This well flowed for months and months, but when they attempted to put the well to pumping it

wouldn't pump and they had to find out why it wouldn't pump and when they pulled the tubing out they found a damaged working barrel and so on. I saw the tubing and pump after it had been pulled out of the well and it was laid out on the ground. I didn't examine it very carefully. They told me they could not make the well pump and that the barrel was damaged from the acid. This tubing was replaced, but our company did not replace it. The owner of the well did this. This Schaeffer well No. 1 of the McClanahan Oil & Gas Company was treated August 9, 1932.

Referring to the next treatment in my notes, I find that on August 11, 1932, I treated a well for Witt & Nelson of Muskegon, Michigan. There was no pressure on this well and they furnished a pump from the Dixie Pipe Line Company. I never heard what results were obtained from treating this well and I never heard whether any damage was done to the well or not. I do not know the name of this well.

The next well that I treated was on August 15, 1932, according to my notes marked PX-218-C. This well was treated for the Michigan Oil & Gas Company, but I do not have the name of the well. The acid was put into the well with the Mt. Pleasant Cementing and Mudding Machine pump, but I do not have any records of the pressure or the results of the treatment. Neither do I have any record of the amount of oil used. I have no record that any damage was done to this well.

According to my notes the next well I treated was on August 16, 1932, for the Columbia Oil & Gas Company. On this day I treated two wells, each with 500 gallons of acid. I do not have the names of the wells and I do not have any records of the pressures used or the results of the treatments. I never heard of any damage being done to these wells as a result of treating them. My records on these wells appear in my notes on the page marked PX-218-C.

The next well I treated was on August 18, 1932, for the Columbia Oil & Gas Company. I used 1000 gallons of acid and 300 pounds pressure, using the Mt. Pleasant Cementing

and Mudding Machine Company's pump. I do not know the name of that well, nor what results were obtained by treating it. I do not know whether or not any damage resulted from that treatment.

On August 24, 1932, I treated a well for the Talbot Oil Company. This well was known as the Adams No. 1 and I used 500 gallons of acid and no pressure. I was never told what the results of this treatment were and I never heard of any claim being made for damage to this well resulting from treating it.

All of these wells that I was treating were comparatively new. The Schaeffer well treated for the G-Lee-P Company and the Malcolm well were new wells which had just come in.

The next well that I treated was on August 24, 1932, when I treated a well known as the Jones No. 1. This well was owned by the Jones Oil Company & Voorhies. On this well I used 500 gallons of acid and no pressure. I have no record of any pressure and I have no record of any production or claim for damage. My notes on this well appear on that page of my book which has been marked PX-218-C.

The next well I treated was on August 26, 1932, for Schuller, Voorhies, Wilson and Strange, they were the owners of the well. The name of the well was the Reimenschneider No. 1. On this well I used 1300 gallons of acid, but I have no record of how much oil was used, but my records show that 150 to 300 pounds pressure were employed. I do not remember the amount of oil this well produced, but I think that the acid helped the well considerably. I had charge of this particular well and worked for the people that operated it, and when we went to put this well back to pumping I had to insert a new working barrel.

The Court: What part of this information is from your memorandum that you are looking at, and what part is just from your memory? A. This is just the part from the memorandum, the number of the well, the number of gallons and the pressure, that is what I have here.

The Court: All right.

At this point the witness produced and explained a standing valve which is stationary in the bottom of the pump barrel at the bottom of an oil well, and a working valve which is attached to the lower end of the sucker rod and works up and down in the pump barrel. The standing valve was offered as PX-219 and the working valve as PX-220.

The perforated pipe is located on the bottom, right directly under the barrel. In making these acid treatments I removed the plunger, corresponding to PX-220 and the part corresponding to PX-219. You lower the rod with part 220 attached until it rests upon part 219, and then you turn it and the two are screwed together, so that the part 219 will come out when the rod is pulled. The tubing was left in the hole and the working barrel is always in the hole when you give an acid treatment. If there is any damage to the pumping equipment from the acid treatment, it usually roughens the inside of the barrel, which has a highly polished finish, and then the acid eats the threads out, inside and outside, so far as it comes up on the outside of the tubing, and loosens the collars so that they have to be removed. As to whether the acid affects the valve seat for the part PX-219, I have removed them already when that seat would be so damaged that it wouldn't hold the valve. It only takes a leak, probably a hair to go through, to keep a well from pumping. The most damage would be your valve would be roughened so that it would cut these cups and it would only last a few hours.

In connection with the treatment on August 26, 1932, of the Reimenschneider well No. 1 for Schuller, Voorhies, Wilson and Strange, I had to put in a new working barrel. This was because the working barrel had been damaged from acid standing in the well. In order to insert a new working barrel it was necessary to pull the entire tubing. There was no claim made for damage on this well. I was in charge of the well and when it needed servicing I had it done. We did not request compensation from the Oil Makers or from my company for this damage. I merely reported my findings to the owners of the well.

The next well I treated was on August 28, 1932, for the McClanahan Oil & Gas Company. The name of the well was the Struble No. 2. I find a report of this well on the page of my notes marked PX-218-C. I used 1000 gallons of acid in this well and 75 barrels of oil. The well was treated under 800 pounds pressure. We had some complaint there on damaged tubing. I do not know what adjustment was made as a result of this complaint. The reference I make to damage is from my memory. I do not remember what the production of the well was before or after treatment.

My next notes as to the treatment of wells appears on that page of my notes marked PX-218-D, and the next well I treated was on August 28, 1932, when I treated a well owned by the Gordon Company and Columbia Oil & Gas Company. The well was known as the Tanker No. 1. I used 1000 gallons of acid in this treatment. We didn't get any results. It was a dry hole. I have no record of what pressures were used on the well. There was considerable damage done to the tubing in this well and also to the casing, but I do not remember what if any settlement was made. I know nothing about what, if any, settlement was made. This well, the Tanker No. 1, is about one and a half or one and three-quarters miles from the Struble well No. 2. In those days it would take me anywhere from a few hours to several hours, or a couple of days, to make one of these well treatments.

I treated both the McClanahan's Struble No. 2 and the Gordon Oil Company and the Columbia Oil & Gas Company's Tanker No. 1 on August 28, 1932. If I remember correctly, the McClanahan well was treated in the morning and I finished up the work in the afternoon. At that time we started in using two trucks and I went over and treated the other well in the night. As nearly as I can remember this Tanker No. 1 well was treated at night. I did not see the tubing and the casing of this Tanker No. 1 well after treatment. I was well acquainted with the farm boss in charge of that well and he told me of the damage that was done. His name was Roy Duke. He now lives about 15 miles out of here in the Wisner oil field.

On September 1, 1932, I treated the Schaeffer No. 1 well for the McClanahan Oil & Gas Company, using 1000 gallons of acid and 300 pounds pressure on the casing and 50 pounds pressure on the tubing. 123 barrels of oil was used. I do not know the results of this treatment and I never heard of any damage to this well as a result of this treatment. This was the second treatment on this well. When this well was treated the first time they had a damaged working barrel as I recall it. The well production went down and the McClanahan Oil & Gas Company wanted it retreated. The retreating had nothing to do with the damage resulting from the first treatment. So far as I remember when I retreated this well I used exactly the same kind of acid and same method of treating it as I did when I treated it before and damaged it. In each case I used the acid that was delivered to me for treating these wells. This is the well that I referred to as making 1000 barrels of oil after it was treated the first time. I do not know how long the acid was in the tubing on this Schaeffer No. 1 well when it was treated the second time.

On September 6, 1932, I treated a well for the Stork Oil Company. I do not know the name of this well. I used 500 gallons of acid and no pressure. I do not know anything about the results of that treatment and I do not recall that any damage resulted to this well from treating it.

On September 11, 1932, I treated the Schaeffer well No. 1 owned by the G-Lee-P Company. This was a retreatment of the same well and this time I used 500 gallons of acid. I do not remember what results were obtained from treating, but there was no damage done to this well the second time. No pressure was used in this treatment. This is the same well that I had previously treated on August 7, 1932. The first time this well was treated I used 1000 gallons of acid and when I retreated it I used only 500 gallons. The first time the well was treated the tubing was damaged. I do not know whether or not this second treatment to the Schaeffer No. 1 well belonging to the G-Lee-P Company was given in settlement for damage done to the well in the first treatment. I do not know anything about that.

My records show that the next well I treated was on September 12, 1932, for the Talbot Oil & Gas Company. I do not have any record of the name of the well that was treated, but my records show that 500 gallons of acid were used. That is all the information I have on this well and I have no personal recollection whatsoever of the treatment other than these records for this well.

The next entry I have is dated September 12, 1932, and I treated on that date a well for the Columbia and Gordon, using 1000 gallons of acid. I have no record of what pressure was used, nor any record of what the results were. I do not remember of any damage to the well as a result of the treatment. If I remember correctly the Talbot well that I treated on September 12, 1932, was right across the road from the Columbia and Gordon well that I treated on the same day. We treated two wells on that day and the acid must have gone in pretty quickly.

That is all the entries I have concerning wells that I have treated with acid. That is the last well that I treated for this organization, and when I quit working for them I talked with my associates and told them that I was quitting. I told them that I believed that the business was too big for us. We were causing more damage than we were making money to pay for. I also told them that unless we found some way to use the acid without causing so much trouble to the steel material in the well, that it was useless to continue to use it. I talked to Mr. Charles Dougherty, Mr. Fred Markey and Edgar Lee.

Mr. Lyon: I would like to object to this conversation, Your Honor, as not admissible against the defendant in this case, particularly in view of the fact other witnesses who have been here on the stand weren't asked about any such conversation.

The Court: Overruled.

My conversation with these gentlemen took place in my little field office on the Grubb farm. I got no money out of my work in connection with these acid treatments for Mr. Dougherty, Mr. Markey and Mr. Lee.

I received my income from the G-Lee-P Oil Company, for whom I took care of certain wells. Also I took care of wells owned by Charles Strange, Schuller, Wilson and Voorhies. Some of these wells that I treated with acid I was being paid to take care of. So that I was present at some of these wells in two capacities, one because I was being paid to look after them by the well owners and the other because it was being treated by the group of four men, of which I was one.

While working for the organization of Dougherty, Markey and Lee I treated about 27 wells. Some of the wells that I treated I was being paid to take care of by the well owners, but I had no interest in the wells I treated for the Stork Oil Company, the Talbot, the Gordon, or the Columbia Companies, and I had no interest in the Jones wells, nor the Malcolm wells. The owners of these wells were not paying me to take care of their wells, and I did not get paid to take care of the McClanahan Oil & Gas Company's wells, nor the wells belonging to J. C. Arthur. I did get paid to take care of the wells belonging to Goll-Graves and Meckling, the wells belonging to the G-Lee-P Company and the wells owned by Strange, Schuller, Voorhies and Wilson.

In the first two wells that I treated, which were for Goll-Graves and Meckling, I put the acid into the well with a bailer. In doing this the tubing of the well was pulled out and the bailer full of acid was lowered into the well.

After we had treated a well, and the well was flowing oil, there was no way in which we could tell whether or not the equipment of the well had been damaged until after the well quit flowing and the equipment was pulled out of the well. This might be any length of time after the acid was put into the well. As long as the well was flowing we did not operate the well pump. Then when the well stopped flowing and we started to operate the pump we would discover the damage which had been done to the pumping equipment.

CROSS EXAMINATION

None of these notes that I have referred to, PX-218-A to 218-D, record any damage or claim to damage in connection with any of the well treatments I have referred to. I have no records of any damage. My notes and records on these wells I treated were usually written up either at the well or when I came in off the job. I didn't wait and write up several wells at a time. Referring to the notes appearing in my records dated June 22, 1932, and June 29, 1932, these notes were made as I did the work. This was not always at the well. I usually made the record and notes after I got through with the job. I made these notes after I had done the work, usually right after when I went to my office. With respect to the entry concerning the well treated on June 22, I probably made the notes on that well the same day the well was treated.

I certainly think that I did make the notes on the same day that this well was treated, on June 22, 1932. I probably made the notes concerning the well treated on June 29, 1932, on the date the well was treated. I usually did my bookkeeping when I was on the job after my day's work, and when I came in of an evening. I usually carried this little memorandum book in my car, sort of a scout book. I kept records of various things in it.

I have no objection to you looking at the rest of this loose-leaf book from which these pages, PX-218-A to PX-218-D, were taken. I do not think that there are any records of any other acidizing jobs appearing in this book at all. At that time we did not have regular little slips to fill out for the jobs. Later on this organization did have regular slips to fill out, but I do not know when this started.

Mr. Lyon: Now, I have gone through this whole book and so far it is just what you call a log. Would you call that a form for a log? A. Yes.

Q. And it has got data in there, and these are all printed forms of logs. Then we come over here to the end

of the book and we find some blank papers, pages, and there isn't anything on those pages, is there, except these four that you have taken out of here? A. That is all.

Q. So the only thing in this whole book are just these entries on these printed forms of logs, and then these particular four pages? There is nothing else to correlate these dates or they are not—the papers are not in any sequence that you can compare with any records before them or any records after them; is that correct? A. Well, they would correspond with the various companies books records.

Q. I am asking you about this book. A. Well, that has nothing to do with it. That is just merely a notebook.

Q. But I mean here we have a loose leaf notebook made up of printed logs. We have some blank pages at the end, and the only thing, the only writing in these notebooks are these four pages. Maybe there is a couple of notes or a couple of words on one or two of those, but the four pages which you have offered in evidence here from this loose leaf notebook, these are not—the point I am making, Your Honor, is that these do not fit into any diary of any kind.

The Court: Let me ask him, did you treat other wells besides these? A. Yes.

The Court: You have since then? A. Yes.

The Court: How do you keep your records of those wells? A. Since I have been in business myself, I have a bookkeeper and I have everything up in form.

The Court: Well, is this the book you get your minutes from for your present bookkeeping? A. No. I haven't used that book in years.

The Court: Well, what is this, anyway? I haven't read it, or looked at it. A. That book is prepared principally for scouts to keep well records in, go from well to well, into the field, during the process of drilling. There are several thousand dollars worth of business right in that little book. Each one of those records in front there, each page is a complete record of a well drilled. It represents several thousand dollars in each record.

The Court: How is that? A. Each one of those well records means a lot of business.

The Court: Drilling well records, you mean? A. That is right, yes.

The Court: Are you in the drilling business? A. Yes.

The Court: These are records of wells you have been interested in that were drilled? A. That is just some of them.

The Court: That is what I would call a log, maybe. A. Yes.

The Court: Of particular wells? A. Yes.

The Court: What kind of a record do you keep of wells you treat? You say you are in the business now of treating wells? A. No, I don't treat wells now.

The Court: You have treated other wells than these? A. I have had these various companies treat wells for me in the southern part of the state.

The Court: Have you got a record of that? A. We have records in our office of all those jobs.

The Court: All right.

I do not know whether I ever showed the sheets of my notes, PX-218-A to D, to anyone while I was doing this work in 1932 or not. I don't know of anybody that I showed these notes to at that time. I never had occasion to show them to anybody.

I made these records with both a fountain pen and with a pen dipped in a bottle of ink. I had both. Some of the notes are made in pencil. I did not make out all of these notes at the same time. I do not know whether or not I can show you which notes I made with a fountain pen and which I made with a pen and a bottle of ink. I do not know. I am not a writing expert. I carried this book in my car and I made some of these notes at my office and I made some of them at the well. They are my original notes. At the time of making these notes I did not first make some record at the well on some paper and then transfer those notes over into this book.

The Court: Then how would you get—I was thinking you did that. That is the way I was explaining one where you got the 7th of August ahead of the 6th. How can you

explain that? Turn to those sheets that I have in mind there. Let me see if I can find just what I want to call your attention to. Here is where it is. There you have got August 6th commencing ahead of August 5th. Running down the whole page here you have August 1, August 2, August 6th and then August 5th. A. These are crossed out here.

The Court: Yes, it does look as if you changed it. A. I am not a very good bookkeeper. I don't remember.

The Court: I thought an easy explanation was what I said before, but you say that isn't right, that probably you made some memorandum at the well. A. Some was made at the well and some was made afterwards.

The Court: But you say they are all made right in this, a memo of them made on another piece of paper and then transferred in here? A. Well, they could have been in one or two instances, not very many.

If the well was creating any pressure at the top of the well through its own gas conditions, then we had to fill the well with oil before we could pump the acid down. Some of these wells we could fill with oil and some of them we could not. Where I have said that the well had so much pressure either at the casing head or at the tubing or elsewhere, by that I mean that it was a well that I could fill with oil as distinguished from a well that I have called a vacuum well. In a vacuum well, if I attempted to put oil in it, the oil would flow right away into the formation. When I wanted to acidize one of these pressure wells, as I call them, the first step would be to fill the well with oil so that the tubing was full down the inside and the well was full to the top between the tubing and the casing.

In addition to the oil in the tubing and outside of the casing, there would be many wells that would have little channels and outlets in the formation so that the well would have quite a capacity for holding oil in addition to the oil in the tubing and casing. The next step in treating the well would be to pump the acid down through the well tubing. In order to do this it would be necessary to open

up the well at the top between the tubing and the casing so that I could let the oil flow out from there at the top of the well to compensate for the acid that I was pumping into the well through the tubing. Then as I pumped the acid down the well and the oil continued to flow out at the top of the well between the casing and the tubing, I would continue the operation until acid had reached the bottom of the tubing and perhaps just started out of the bottom part of the tubing. I held a back pressure on the top of the casing so that the acid is held in the well where you want it.

When the acid starts to come out of the bottom of the pipe or tubing, it is then necessary to close in the top of the well between the tubing and the casing and stop the upward circulation of the oil. Otherwise the acid will turn around the outside of the tubing and start up the well between the tubing and the casing. Therefore, at some stage or another of the treatment I had to determine when I was going to close in the top of the well and stop the oil from coming up out of the well between the casing and the tubing. After I had closed in the top of the well I continued pumping and the effect of that was to pump the acid back into the formation. I then continued pumping until I had pumped the acid out of the tubing and back into the formation, and after I had got all of the acid in the pipe that I was going to put down into the well, then I pumped the oil into the pipe on top of the acid. I must know how much acid to pump in to get the acid out of the tubing at the bottom.

Mr. Lyon: All right. Now, you have to make a lot of calculations to do that. You have to calculate the volume of the tubing and you have to calculate how much liquid to pump down there, until your acid starts flowing out of your tubing, so as to tell you when to shut off your well at the top, between the tubing and the casing, and you have got to be able to calculate how much fluid to pump in on top of your acid to get your acid out of the tubing; that is correct, isn't it? A. Yes.

Q. Now, that was all new to you, wasn't it, when you

were doing this work? You had never been in the oil field operations which required that kind of calculations and that kind of operations that we are talking about? A. We knew how much oil to put in, certainly, in a given number of feet of tubing.

Q. Well, I mean this, that this business of making this kind of calculations, when you would go out to a well and find a well of a depth you hadn't had before, and operating your pump so as to get in just the amount of fluid you had calculated you should, that was new work to you, wasn't it?. A. Yes.

Q. You had never done it before, you were not an expert or experienced in this kind of operation until you took up this acidizing with pumps? A. It was new to me.

Q. And all the trouble that you had was occasioned by something going wrong and your failing to get your acid out of your tubing or in one or two instances, I think, you said you got some to come back up around the tubing on the outside of the tubing, at the bottom. It was all a case of not getting your acid in the right place, wasn't it? A. No, I wouldn't say that.

In treating these wells I have been talking about I had no trouble with those wells that were treated on a vacuum. In treating the wells that required a pressure, I had trouble because the acid would not go into the formation, so I would keep trying for hours to get the acid into the formation. I did not reverse the circulation in the well and take the acid out of the pipe at the top of the well, but I did take a swab and try to swab out the acid. In some instances where I did have trouble with the well I also tried to swab those wells. I do not know how you are going to determine whether you have taken the acid out of the well fast enough, or how you are going to determine if you have left the acid in the well too long. At the time of treating these wells that I have been talking about I had the only type of equipment that was available at that time. At that time there were no pumps constructed to pump acid. Today they have special pumps to do this that will work in a way

our pumps would not, and that will work under conditions that I encountered when treating these wells. Also today they have better inhibitors.

I have seen the pumps used by the Halliburton Oil Well Cementing Company in acidizing wells, and they have some very fine equipment now. When treating these wells I had little pumps that would pump up against a pressure, but they were not constructed or not built to handle acid. The pumps of that day had fiber packing in the cylinders and pistons and after a few hours of service under pressure they would wear out. These pumps had common brass or steel liners. The pumps I used to pump acid with had some brass or bronze parts in them which contacted the acid. I do not know whether the acid would take out part of the brass or copper, but I do know that after these pumps were used one or two times they had to be thrown away.

Usually the cast iron, bronze and brass working parts of the pump would be eaten out. The equipment used today in pumping acid into a well is capable of some very high pressures. The present day acid pumping equipment is powerful and has plenty of capacity, and there are pumps especially built to assure that acid gets down and out of the pipe against ordinary obstacles. The present day practice is that when the formation will not allow the acid to penetrate, the circulation is reversed and the acid is removed from the well. But we did not do any of these things in 1932.

Of the various acid treatments that I have been telling about, I believe that we encountered trouble and damage to the well for the first time when I treated the Hastings No. 1 well for Wells and Malcolm on July 24, 1932. On this treatment a pump was used and pressure was applied to force the acid into the formation. I do not remember how long the acid remained in the tubing on this well or in the working barrel. The acid was probably in the well for some time, possibly until the next day, I presume. The damage and trouble was caused by leaving the acid in the working barrel. That was one of the first wells that I had

ever had any knowledge of being treated under pressure, and at that particular time nobody knew anything about treating a well under pressure. That was the first well I ever saw treated under pressure and I attempted to do it myself. I did not treat this well the same way that I would if I were going to do it today.

The next well on which we had damage to the tubing as a result of acid treating it was a well owned by the G-Lee-P Oil Company, which was known as the Schaeffer No. 1, and which I treated on August 7, 1932. In this particular case I do not know just what happened, but the acid did come back up out of the well hole. The acid would be permitted to come back up out of the well hole by leaving the well open at the top between the tubing and the casing, or the acid might come back up out of the well hole as a result of a leak in the casing. Sometimes all calculations fail and something happens that you do not figure on. In those days we did not cement our pipe. Today we cement our strings of oil pipe and there is no possible chance for it leaking from the casing seat. I cannot tell what happened in this particular Schaeffer well No. 1 of the G-Lee-P Company, which permitted the acid to come up around the outside of the pipe. I do not know whether this was preventable or not.

The next well that I treated in which damage was done to the well was a well known as the Schaeffer No. 1 owned by the McClanahan Oil & Gas Company. This well was treated August 9, 1932. I do not remember exactly what the trouble was there, but as I recall Mr. Crampton had to replace the working barrel when they attempted to pump this well. This well was increased to 1000 barrels per day as a result of the acid treatment, but I do not remember how long this increase held up before they had to put the well back on the pump. I do not remember how fast the production of this well declined. It wasn't over a month, but I do not remember. In this well that we damaged I would say that the working barrel would cost around $24 to $25, or something like that.

Mr. Lyon: And you had recovered maybe 30,000 barrels of oil because of the acid treatment, I think you admitted this morning, didn't you, that they would have been glad to have bought several working barrels, if necessary, in order to get the results of that acid treatment? A. They were a pretty happy bunch.

I have been a farm boss in charge of oil wells and have had a lot of experience in that line. I have had to pull a lot of pumps and replace a lot of working barrels where there had not been any acidizing in the well at all.

In sand fields the working barrels wear out during the normal pumping operations. In flowing wells you do not have any pumping troubles in connection with your pumping barrels. It is not true that if you allow a well to flow through one of these working barrels that it is common to have them cut off or pit out, so that when you want to put the well on the pump you have to pull the tubing and put on a working barrel. This never happened to me.

I have been farm boss for the Sinclair Oil Company in Texas and Oklahoma, where I was in charge of flowing wells. I was in charge of wells flowing through working barrels, and in south Texas I was in charge of wells that flowed as high as 10,000 barrels. It is, however, a common thing in pumping wells to have to replace the working barrels when they wear out from all kinds of reasons. To replace a pumping barrel is no particular tragedy. It is part of your operating cost of the well.

The next well which I treated and to which damage was caused as a result of the acid treatment was the Gordon Oil Company's Tanker No. 1 well, which I treated on August 28, 1932. In the treatment of this well the acid would not go into the formation as it should and I had to leave the acid in the pipe. That was the cause of the trouble, leaving the acid in the pipe too long, and under present day practices this would be preventable.

The Court: How did you determine how much acid the tubing would hold? A. At that time I had a book that was prepared by the National Supply Company, or the

National Tubing Company, and that gave it to me, and I could look in that and determine at a glance what any size tubing would hold.

The Court: When you were trying to put this acid in under pressure, where did you stop with your acid, I mean where did you leave the acid, try to force it all out of the casing, or did you leave the casing full of acid, or what? A. It was our intention to put it all in the formation.

The Court: And by following it with oil? A. Yes.

The Court: And the amount of oil you followed it was the amount that by your book you had learned it would take to fill that tubing, and then when you thought you had it forced out then you held it right there under pressure? A. Those days every operator had his own ideas. Some would want to leave it there twenty-four hours, and some would want to leave it there seventy-two hours.

The Court: What you thought you had done was to put enough oil in to just fill your tubing, and therefore had crowded all of the acid out of the tubing? A. Yes.

The Court: Isn't that right? A. That was it.

Mr. Owen: To fill the tubing and the well hole around the bottom of the tubing, that is put in enough oil not only to fill the tubing, but also the well hole at the bottom of the tubing, so as to force the acid out into the formation.

The Court: How would you determine the capacity of the oil hole at the bottom of the tubing? A. That is one thing you couldn't do.

Mr. Owen: Can it be done today? A. Yes. Well, it has been—I can't do it, but the chemists, if they know how much acid you have used previously, they can tell you the cavity you should have. They have worked it out.

Q. For re-treatments? A. For re-treatments. They have worked out a system whereby they are quite accurate.

The Court: Well, why can't you work it out this way: You can compute the amount of oil that is in your casing, can't you, and then if you know how much oil you put in— A. There is a lot of things around an oil well you just can't tell how you know it.

The Court: You didn't know how to tell the capacity of the hole at the bottom of the tubing? A. You can't tell that exactly.

The Court: All right. A. Because you don't know how much pressure is there, or how much it is going to take.

Another well which was damaged as a result of acid treating was the Reimenschneider well, belonging to Schuller, Voorhies, Wilson and Strange. This well was treated August 26, 1932. This was a hard well to treat. We probably did not get the acid out of the working barrel.

Another well that we treated and damaged was the McClanahan Oil & Gas Company's well the Struble No. 2, which was treated August 28, 1932. In the well there was some damaged tubing. I never saw the tubing, but I was told about it. I do not know how many joints of tubing were damaged, and I do not know whether the damage was on the inside or outside of the tubing. I was just told we damaged some tubing there but I do not know how I did it. On this Struble well No. 2 I remember that it was a hard well to get the formation to take the acid. The pressure we used in treating this well denotes that it was a hard well to treat. When I say that this was a hard well to treat I mean that the acid would not go or flow into the formation and I had to put a lot of pressure on the acid and still it bucked the pressure. First you must understand that when this oil country was new, they carried a rock or bottom hole pressure in the bottom of the well around 1000 pounds. You take one of those wells and it would be a tight well. It would be a producing well but there would be only a very small amount of porosity in the formation. You had to buck that rock pressure in order to get your acid to flow against the pressure or rock pressure in the bottom of the well hole. In the treatment of this Struble well No. 2 I am confident that the injury to the tubing was caused by the difficulty in getting the acid out of the pipe, and because of the equipment and method we had and knew about at that time.

The Court: In fairness to this witness, I want to ask

him just a few questions, and then give counsel an opportunity to further cross examine him, if he wishes. (To the witness): Am I right in my understanding that these sheets that you have produced here from your little loose-leaf book, were either written just at the time that you treated the well, or shortly thereafter? A. They were written, that is right—they were either written at the well, or on the same night, or the next day at my office.

The Court: And did you have to go back to them and do anything to them after that? A. To rewrite them?

The Court: Yes. A. No.

The Court: And these are just in the condition they were when you first made them? A. Yes. I have not thought of these things for five or six years.

The Court: If there was any damage to any of these wells, how soon after that did you usually learn about it? A. As soon as you had to put your well to pumping.

The Court: How soon? A. If your well didn't start off going after it was treated, you learned about it within a day or so, or as soon as your well blew the head off. If the well started out flowing, and it flowed, you wouldn't know anything about damaged tubing until you had to put your well to pumping.

The Court: About how long would be the early date on that, to hear about that? A. Well, if you treat a well today, and leave it say for 72 hours, and then open your well up, and it didn't flow, you would swab it first; and then if you couldn't make it flow, you would put your pumping equipment in and try to pump it.

The Court: You didn't make the final entry in your notes until after you were through treating. As I understand, you waited, for instance, to tell how much oil you would put in, and how much acid, and all about the pressure and those things. You didn't make those entries until you finished treating, did you, finally make these entries in this book? A. No.

The Court: Did you when you were there find out if there was any damage to the well? I am trying to get an

idea as to when you completed your work. I know that if you are right there you wouldn't be likely to find out about damage unless you were doing something. A. In some places you would know right away, and in some places your fluid would start coming up on the outside of your casing, and in that case you would have to—

The Court (interposing): I will tell you this frankly, what I was trying to do was let you explain to yourself, and if it is not a good explanation, don't take it, but I didn't know but what you made your entries about your treatment of the wells when you were there, as far as the entry was concerned, and you never went back to it and did anything—and, if later on you found out that the well had been damaged, that would explain why you did not get that in there, see? On the other hand, if you were entering it right at the time from your experience, and from your personal knowledge about the thing, I would have difficulty in seeing why you didn't put down damage to something, because it seems as if that would have been the interesting and helpful thing to do. A. The damaged material would show in the company's books that I had charge of at that time but not the other people's.

The Court: I see. I didn't know but if you weren't there at least it would explain the things you didn't hear about until several days later; it wouldn't be on the books.

Mr. Wiles: After you had pumped the acid down and followed it with the oil, did you stick around until it was pumped out again or did you just go away? A. No.

Mr. Wiles: The well operator finished up the emptying of the well? A. They would do their own pumping. When they got ready to open up the well, they opened it up and done what they saw fit. I didn't do anything to those except the wells I actually had charge of.

The Court: The degree of supervision is very far short from what I understand Dow or Halliburton or oil treaters do now, a much lesser degree. A. There is no comparison with what I did and what you do today.

The Court: And the division of labor. You put the acid down in the hole.

Mr. Lyon: I think it would be interesting to the court if you would just explain what you meant by that. The witness said "There is no comparison with what I did and what they do today." Will you just give the court a picture of that difference? A. Well, at that time, we just knew hydrochloric acid would open up the porosity and let the wells make more oil. That was all we were practically interested in. After we started developing the process and began to damage wells and make good wells out of practically dry holes, and spoil good wells, then your chemical engineers entered into the picture.

The Court: How did you spoil good wells? A. By eating out the casing seats.

The Court: That didn't hurt the well. A. Oh, yes, it would. Let the water in from above. If you damaged your casing seat or caused the casing to start leaking in the bottom of the well, the water would start leaking.

The Court: You are talking about casing seats now. You haven't told us of any of that kind of experience you had.

Mr. Lyon: The casing seat isn't some casing. It is some limestone around the bottom of the casing you are relying on to keep the water out, isn't that correct? A. Yes.

The Court: It isn't the other seat we are talking about?

Mr. Lyon: Oh, no. It isn't a metal seat at all. It is the formation you are relying on to keep the water out.

The Court: That would develop with inhibited acid as well as any other acid? A. Yes.

Mr. Lyon: What do they do now that is different from what you did in those days? A. Well, today they have highly trained boys whom they have sent to school and studied these different methods, who are chemical engineers, usually.

The Court: Some of these "Doctors." A. They used us boys in the field who worked at this in the beginning, our experiences, and the laboratory experiences, and they

built this thing up to where it is today. Where we had a $75.00 or $100.00 pump to do our work with, they have pumps today that cost $15,000, $20,000 to build, made out of special alloys.

Mr. Owen: Was it made out of alloys that are not attacked by the acid? A. That is what they tell me. I don't know that part of it.

My notes that I have been referring to in connection with these well treatments, which notes comprise Exhibits 218-A, B, C and D, I had these notes filed away in my office and I had not looked at them until about two weeks ago. About two weeks ago I had occasion to look at these notes when Mr. L. W. Lee came to my house and asked me if I had any records or remembered anything about the acid work that I had done at that time. I told Mr. Lee that I did have some records and I remembered a lot of the acid work I did in those days. Then in a few days Mr. Conner and Mr. Lee came again and asked me again if I had these records. In the meantime I had located the records. I found the records in my office, and no change has been made in these records from the time I found them in my office two or three weeks ago until the time they were brought here into court today. I have had these records and notes in my possession all of this time.

Mr. Lyon: Mr. Sprenger, do you believe you were the first person here in Michigan to go in the acidizing service business, offering acidizing as a service to the well operators, as distinguished from an oil company having its own employees do the work, and buying the acid from somebody? A. We were the first that I have any knowledge of.

Q. At the time you started in the business, so far as you know, the Dow Company had not yet entered into the service business, is that correct? A. No, they hadn't entered into at that time, although we did treat wells on the Grubb farm before I did this work.

Q. Yes. You yourself had done some early work, and that you have reported here? A. Yes.

Q. The point I am getting at is you saw the possibili-

ties, you four men saw the possibilities of this service business, it is your own idea, you didn't copy somebody else, and you started it before anybody else, and Dow came into it afterwards? A. I got my first experience with Dow, from Dow's man.

Q. Doing what? A. Treating the first well.

Q. You bought the acid from them, didn't you? A. Yes.

Q. He came out and showed you how to use it? A. Yes.

Q. But this idea of going into the service business and starting a service company, you were the first with that idea, you four men? A. We were the first that I have any knowledge of doing it.

Q. It was your own idea; it was not suggested to you by somebody else? A. No. I figured it would be a mighty nice business.

The Court: I think while this is right here before me, and I don't close my mind to these things until I decide a lawsuit, but I think I will say on the record that my present impression is that these records are genuine. I don't think they have been made up. I may have asked some questions, I always do, to try and find out things, but I think the records are genuine, in other words, that he made them at or about the time he was treating the wells.

Evidently what he had in mind was whether this acid was going to eat the rock or not and the success of making greater producers. He certainly didn't start out with the idea of how much damage was going to be done to tools, and in spite of the fact he doesn't accept my offered explanation, I am inclined to think it would be a little later that he found out about any damage, that if he did find out was done, and therefore that is to my mind a satisfactory explanation as to why there isn't anything at all about damage in these records he has got.

I think I should add right on there, however, that there not being a word about damage to any of these wells, he depends entirely on his memory, and we can see as to some

of these things, for instance, as to when he began to keep records, and some things, he is quite faulty as to his summary, and this does depend entirely as to the damage and amount of this damage on his memory, and isn't helped in any respect by the record he has made.

REDIRECT EXAMINATION

As I recall the very first well I ever treated with acid was treated on June 3, 1932, for the G-Lee-P Oil Company and the well was the Grubb No. 2. I obtained the acid used in treating this well from The Dow Chemical Company. I would not be positive as to the date of this treatment. It is just from memory. I have no records of this treatment, the records were kept by the G-Lee-P Company. The name of this well was the Grubb No. 2. The acid for this treatment was delivered to our place in wooden kegs and was brought there by Edgar Lee's trucks. Edgar Lee got the acid from The Dow Chemical Company. Prior to that time, June 3, 1932, I had witnessed an oil well being acidized to increase production. My memory on this is kind of hazy and I can't say exactly whose well it was or who made the treatment, but I think it was the Pure Oil Company and they put acid in the well. I didn't know about it and they wouldn't tell me. But I did know that the wells were being treated. All I know about the acid that was used on these treatments by the Pure Oil Company is what I saw on the labels on the acid tanks. They were big labels saying "Caution" and stating that it was very dangerous, to keep away, and the labels bore the name of The Dow Chemical Company. I learned of the treatment of these wells by the Pure Oil Company before I treated the first well for the G-Lee-P Company. I learned of the Pure well being treated along about May of 1932.

FRED CRAMPTON,

a witness called by plaintiff, testified as follows:

DIRECT EXAMINATION

My address is Shepherd, Michigan, and I am superintendent of production for the McClanahan Oil and Gas Company. I have worked for that company since the 22nd of July, 1931. The McClanahan Oil and Gas Company owns wells named the Struble No. 2 and the Schaeffer No. 1. Both of these wells are located in the Greendale Pool, Midland County, Michigan.

The Struble No. 2 well was treated with acid by Dougherty & Markey in the fall of 1932. The production of this well was increased. Its production was around 40 barrels before acidizing and after it produced about 350 barrels in 24 hours. Mr. Sprenger was in charge of introducing the acid into this well when it was acidized by Dougherty & Markey. As a result of putting acid into the well, if I recall correctly, we had trouble with the barrel and, I think, six joints of tubing which would be about 180 feet in length. We noticed that trouble within about 35 days after the treatment when the tubing was pulled because we found we could not get the well to pump. The acid was in there and we couldn't get the well to flowing; and we had to get it to pump and we couldn't get the well to pump right. Then we pulled our tubing and found six loose joints, the bottom six, and that is where we found those threads on the tubing and the barrel to be pitted.

This tubing had been put into the well about six months before and was brand new well tubing. I saw this tubing after it was pulled. I was foreman at the time and I had charge of pulling it, and I examined it after it was taken out of the well. The tubing was not in condition for re-use in the well. We used it for surface pipe on the ground. We were not able to put it back into a well without first rethreading it.

The Schaeffer No. 1 was also treated with acid by Dougherty & Markey. I do not know the date when it was

treated. It was treated in 1932, probably in the fall of that year. As a result of treating this well we got a nice increase. The well was making about 30 barrels when they treated it and for the first two or three days it produced around a thousand barrels, and then of course it dropped off so that within thirty days after treatment it was making around 125 barrels. As a result of acidizing this well some damage resulted, but not to as great an extent as in the Struble well, although we replaced a couple of joints of tubing. Two joints of tubing of about 60 feet were damaged and we did not re-use any of that in a well. The working barrel was pitted and we replaced it when we pulled the tubing.

Dougherty & Markey treated quite a few wells for the McClanahan Oil and Gas Company. I would estimate they treated 15 or 20 wells. The tubing in the Schaeffer No. 1 well before it was treated with acid was new tubing. It had not been in the well hole, I would say, over 30 days. The Schaeffer and Struble wells are the only ones that I recall having any damage done to them as a result of acid treating. With reference to the Schaeffer No. 1 well, we discovered the damage to that well when we put the well to pumping. We would not know of the damage as long as it was flowing. We discovered the damage about 20 days after it was treated.

CROSS EXAMINATION

I would not know to what I should attribute the corrosion of the threads on the bottom sections of the tubing of the Struble and Schaeffer wells, any more than I know that it did happen on these two wells. The corrosion was not caused because the acid was not completely pumped out of the tubing and the working barrel during the operation of acidizing the well. The well started off to flow, but I could not state how long the acid remained in the well.

I would say that there was not much difference in time in the Struble and Schaeffer wells from the time they started to put the acid in until they completed the opera-

tion and we got it to flow. It would be between six and eight hours in all. With modern equipment for acidizing wells, they could now do a better job than that. At the present time those difficulties would be preventable with the type of pump and equipment they now have and with the use of the reverse circulation method.

The ledger book of Dougherty & Markey shows under their account with McClanahan Oil and Gas Company that the first acid job they did for us was on July 27, 1932, when they treated a well with a thousand gallons of acid on the Struble lease. The cost was $250. I remember that job and we got a nice increase in production with no trouble or injury to the well equipment or pipe.

The next acidizing job done by Dougherty & Markey for the McClanahan Oil and Gas Company was on July 30, 1932, when the McClanahan Root No. 1 well was treated with a thousand gallons of acid. I remember that job and we got an increase in production, but I do not remember the exact production figures. We had no trouble with any damage there.

Next, the Struble No. 5 well was treated on August 2, 1932, with a thousand gallons of acid. I remember that job and we got a nice increase without any damage.

Next, the Schaeffer No. 1 well was treated August 9, 1932, with a thousand gallons of acid, and that is the well I previously discussed.

Next, the Struble No. 1 was treated on August 28, 1932. This was a retreatment. The production had gone down and we decided to try again. We did not have any trouble with respect to injuring the tubing the second time, and we got good results out of the second job.

Next, the Schaeffer No. 1 well was treated a second time on September 1, 1932, with a thousand gallons of acid. There was no damage to the well on this second treatment and Dougherty & Markey used the same method of treating it so far as I could tell.

The next acid job done for us by Dougherty & Markey was on September 13, 1932, when they treated one of our wells with a thousand gallons of acid, but I do not know the well name.

Then, on September 16, 1932, they treated another well for us on the Struble lease with a thousand gallons of acid, but I do not know the well name.

On September 25, 1932, they treated a well for us with a thousand gallons of acid, known as the Speardeck No. 1 well. I remember that job, and we got a nice increase in production without any damage.

Again on October 3, 1932, they treated a well for us with a thousand gallons of acid, but I cannot identify the well name.

I do not remember that Dougherty & Markey treated the Schaeffer No. 1 well a third time.

The next treatment made for us was on November 12, 1932, when Dougherty & Markey treated the J. D. Wilhelm well with a thousand gallons of acid. I remember that treatment and we got about the same kind of increase we had gotten with the earlier jobs and had no trouble.

The next treatment was on November 17, 1932, when they treated our Morrison No. 4 well. I remember that treatment. We had a nice increase in production and no trouble to the well.

Mr. Lyon: The increases you were getting in November were about the same as you were getting in July and August with the acid treatment? A. The re-treatment wasn't as large as the first treatment.

Q. But where the first treatment was 1000 gallon treatment, you would get the same results as you did with the 1000 gallon treatments in August and July? A. Yes.

The last treatment appearing in the ledger book of Dougherty & Markey under the heading of wells treated for McClanahan Oil and Gas Company is that of the Wilhelm No. 1 well treated on November 30, 1932. I do not remember that this well was treated twice.

We were pleased with the results of the first treatments in July and August, 1932, and thought that they were worth while.

I am still in the oil business with the same company, namely, McClanahan Oil and Gas Company. I have had other experience with tools being damaged in wells that

came under my personal knowledge besides these two wells I mentioned, but I do not know what kind of acid was used.

I had one other experience of a well being damaged from acid which occurred in either 1934 or 1935. This damage occurred in the Ben Wamsey Well No. 1, located in the Denver Pool, Denver Township, and was treated with acid by Mr. Quinlan. It was a well that had just been drilled by McClanahan Oil and Gas Company. It did not flow, so we put the acid in before we ever tried to operate it. As a result of acidizing the well produced about 150 barrels and is still making about 12 barrels per day. The acid treatment was satisfactory. There was some 500 or 600 feet of well pipe damaged by this treatment. Quinlan had treated other wells for McClanahan but this was the last well he treated for us. We had no damage or trouble with the other wells.

I have experienced damage to three wells as a result of treating them with acid and have had acidized, all told, about 400 wells. My first experience with acidizing wells commences in the fall of 1932, and from that date to the present time, including retreatments, I would estimate that I have had to do with about 2,000 acidizing jobs. The three wells I told about were the only ones I know of which were damaged as a result of acid treating them. Of the 2,000 wells which were acidized, I do not know which proportion were treated with raw acid and which proportion were treated with inhibited acid. They could have put water in and I would not know anything about it. The biggest majority of the 2,000 acid treatments have been made by Dowell Incorporated. They have made about 75 per cent of the treatments.

Quinlan did our acid work for about a year, just how many treatments he made for us I do not know. Halliburton Oil Well Cementing Company has also treated wells for us, but only on about two or three occasions. We experienced no trouble or damage when they treated our wells.

CLIFFORD E. WOLMER,

a witness called by plaintiff, testified as follows:

DIRECT EXAMINATION

I live in North Muskegon, Michigan. I have been in the oil and gas business all my life. I worked for and was interested in the Moline Investment Company, whose business was that of producing oil and who operated in Muskegon County, Michigan. I was superintendent of production for that company and worked for them for nearly ten years.

The Moline Investment Company owned an oil well known as the Charles R. Giles well No. 3 which was located in Muskegon County, Michigan. We had this well treated with acid by Dougherty and Markey in the summer or fall of 1932. This treatment with acid did not increase the production of the well. We had four other wells treated with acid by the same men and the acid treatment would, as a rule, increase their production.

When Dougherty and Markey treated the Charles R. Giles well in 1932, I didn't know enough about the acidizing business at that time to know that there was any inhibitor. We had treated one of our wells before that and the acid had gone down into the well and out through the sand. On this Giles No. 3 well the acid didn't go out through the sand, but it piled up and filled up the hole and Dougherty & Markey didn't have the pump along with them that day to force the acid back, so the acid was left in the well over night. I didn't know what to do and I called them that night and told them that the acid didn't go back. So I tried to get them the next day, and I couldn't get them the next day and I couldn't get them the next day. So my only hope was, to save the casing and tubing from eating up and ruining the well, to pump water in there, and I pumped water in that well with an old boiler I had on the lease with a donkey pump. I pumped water in there

for about twenty-four hours and let it flow out in a slush pit. But I didn't want to ruin the well. That was the idea. Well, I couldn't get hold of Dougherty and Markey, so I pulled the tubing out. I had the tubing pulled out of it. When I pulled the tubing out, part of it came out and part of it didn't come out. It was eaten out in such a way that it left part of it in there, so when I went to pull it up, why, it dropped back.

So I pulled the tubing out there and laid it out—there was between four and five hundred feet of that tubing that was eaten up so bad by acid I couldn't put it back into the well, so I got Mr. Dougherty, he came over to see me, and I left it out. He says, "What is the trouble?" "Well," I says, "Come out and see." Well, we went out there. He says, "That tubing is eaten up pretty badly." "Yes," I says, "Dougherty, I am afraid of that casing, but the tubing is all eaten up." I says to Dougherty, "I am going to sue you for the loss of that well," which was making quite a little oil. "No," he says, "don't do that, Wolmer," he said, "We will fix everything all right." "Well," I says, "you treated that well with an acid without an inhibitor in it, didn't you?" "Well," he says, "I guess we did." He admitted the truth. And so he said, "Now, Wolmer," he says, "we don't want no trouble over this," he says, "at all." He says, "We want to fix this well up as good as it was before, and," he says, "we won't have any trouble with you at all."

But he furnished the tubing. I think he furnished four or five hundred feet of tubing. I don't just remember how much. And I run it back in there, in the well, and the casing was not eaten up. There was mud back of the casing which would hold any holes that there might be in there, and the 6⅝ bottom string of casing was mud, if it was, and I never saw the bottom of that casing, to know how bad it was eaten up, but the tubing was eaten up. Dougherty and Markey gave me a new tubing as a result of that.

The Court: Well, you had to fish out your tubing. A. Well, we moved a drilling machine in there, and we tried to fish it out, but we couldn't get hold of it. Well, there

was a portion of the pipe that we couldn't get anything to fish it out with. So we put on a bit the full size of the hole and drove it down to the bottom, and it drove right down, just drove right down. That acid will take all the life out of tubing or anything that is iron or steel. We drove it down there and later we had the well treated with acid with an inhibitor, and that was very satisfactory, and we got very wonderful results.

The Court: Who treated it? A. Well, it was a man working for the Dow Chemical Company. I am not sure whether he was under Dow Chemical Company. He had a contract. His name was Quinlan. He treated the well and the production was very good after that.

CROSS EXAMINATION

The Charles R. Giles well No. 3 is the only well that Dougherty & Markey ever treated for the Moline Investment Company. There was about 400 feet of tubing that had to be replaced in the Charles R. Giles well and it was worth about 30 cents a foot. Dougherty and Markey replaced the tubing. I have never had any other trouble with working barrels having to be replaced after an acidizing job.

The Moline Investment Company had five wells acidized and that is all. The Muskegon Oil Corporation acidized one of these wells and I think a man named Quinlan did the rest of them, as I remember it. This was about nine years ago. The Muskegon Oil Corporation acidized one of these wells early in the summer of 1932. I did not ask them where they got the acid and I do not know whether it was inhibited or not. I think a Mr. Howard did this work for the Muskegon Oil Corporation. I do not know where he got the acid. I didn't ask any questions. The acid was all new to me at that time, and I knew it would help the wells and we were just in the place where we had to have some help.

Mr. Lyon: The reason you had this trouble on the Giles well was because they couldn't get the acid out of the pipe, and they didn't have any pumps there, and they let it

stay in the pipe too long, was that it? A. Well, there wasn't any inhibitor in it.

Q. Well, I mean they didn't get the acid out of the pipe? A. Yes. There wasn't any inhibitor in it and the acid didn't go out through the oil sand.

Q. They didn't have any pumps to pump it out? A. That is right.

Q. So the acid stayed in the pipe longer than it was supposed to, didn't it? A. Yes.

Q. How deep was that well? A. About 2,020 or 2,030 feet.

Q. And how long had the tubing been in the well when you acidized it? A. Well, let's see. That was 1932. About between three and four years.

MILFRED WELLS,

a witness called by plaintiff, testified as follows:

DIRECT EXAMINATION

I live at Zeeland, Michigan, and my business is that of contractor and producer. I am in the oil business and contract to drill wells. I have been in this business ever since 1926, and have drilled and produced oil wells.

In 1932 I was associated with a man named R. D. Malcolm in the venture of drilling an oil well. This was

a sort of partnership or company and we operated under the name of R. D. Malcolm. We owned a well known as the Hastings No. 1 which was located in the Greendale Pool, Michigan. This well was drilled in some time in July of 1932, and was treated with acid to increase its production by Dougherty and Markey. The acid treatment to the well helped its production to the extent that before the treatment the well was making about 30 barrels of oil and after acidizing it made about 90 barrels. As a result of putting the acid into this well, we had some corrosion trouble. We had some 200 or 300 feet of tubing that was eaten up. About two or three weeks after the well was treated with acid, I helped pull the tubing out of the well, and I saw it after it was removed from the well. The bottom of the tubing and the threads on the tubing were eaten up, and we did not put it back into the well, but used it for line pipe on the surface of the ground. The tubing was in such shape that we could not put it back in the well and use it. We wondered how we got it out of the hole. I do not remember Dougherty and Markey treating any other wells for us. But they gave us a retreatment job on that. They may have treated other wells for us, but I do not recall.

As a result of the damage to this well, Dougherty and Markey made a settlement with us by giving us a free acid treatment and they rethreaded the pipe for us, but we did not put it back into the well. We just rethreaded it and used it on the surface. When they gave us a free acid treatment by way of settlement, I do not know whether it was the same kind of acid or not. We had no damage to the well as a result of the retreatment.

CROSS EXAMINATION

Mr. R. D. Malcolm was my partner on this job.

(The witness was shown a ledger book (PX-213) of Dougherty and Markey and his attention called to the account therein carried under the name of "R. D. Malcolm," bearing the entry under the date of October 4, 1932, as follows: "1000 gallon shot, Hastings No. 1, $175.")

Mr. Lyon: Is that probably the account for the job that you have been telling us about? A. I think it was not in October. The first treatment that he gave us was in July.

I do not remember just when they gave us the retreatment, but I know it was along in July some time. I do not know who paid Dougherty and Markey the $175 by check for the acid treatment performed for R. D. Malcolm on October 24, 1932. I didn't write any checks. Mr. Malcolm wrote the checks. I have no way of fixing the date of the acid treatment I refer to without getting it from Mr. Malcolm. He kept the books and everything. I do not know where the acid came from that Dougherty and Markey used in treating the Hastings No. 1 well for R. D. Malcolm.

JAMES R. LEWIS,

a witness called by plaintiff, testified as follows:

DIRECT EXAMINATION

My name is James R. Lewis. I live at Houston, Texas. I am employed by the United States Department of the Interior in an investigative capacity, and have worked for the Department of the Interior just less than eight years, a few months. I am engaged in so-called enforcement work of the Connally Hot Oil Act.

I had occasion to do work of an investigational nature

for Dow Chemical Company or Dowell Incorporated during the period of July and August, 1939, while I was on leave, or furlough from my regular duties that I have just explained. That work took place largely in West Texas and particularly in the vicinity of Odessa, Texas. The nature of the investigation and the instructions that I attempted to carry out was to determine, if possible, whether or not the Chemical Process Company, whose principal place of business was at Odessa, Texas, were using any one of several different metals or other substances in their acid trucks. I had occasion to inspect quite a number of the acid trucks of the Chemical Process in that territory, some fifteen or eighteen altogether, I should say.

Mr. Conner: Now, will you please tell the court what, if anything, you learned during that period about the structure of the tanks of the Chemical Process Company with particular respect to the interior of those tanks? A. The tanks that I observed were of sheet metal construction—I judge steel or some steel alloy. They were more or less of a circular or oblong shape, would hold varying amounts of fluid anywhere from, I should say—this is just an estimate—I should say in the neighborhood of 1000 gallons, and each one of them had at the top and near the back of that tank an entrance frequently referred to as a manhole that could be manipulated, opened or closed; most of those holes were large enough that a man could pass through the entrance to the inside of the tank, if so desired. I inspected the interior of a number of those tanks; probably eight or ten, or more, of those tanks were examined by myself during that time.

Q. Did you have occasion during this period of July and August to see the Chemical Process treat any wells with an acid? A. Yes, I did. I went with them on a number of occasions from Odessa, where they loaded the tanks with the acid solution, to the well locations, in certain instances.

The Court: How did you arrange to do that? A. The driver of one of the trucks I made friends with. He, of

course, didn't know my object in making the trips. I didn't explain to him the real object of it but told him I was interested in learning as much as I could about the manner of treating these wells and the effects obtained. I was invited to go with them.

The Court: You weren't employed by any of those people down there? A. No, sir, not at all.

Mr. Conner: Did you on any occasion see the Chemical Process treat any wells with acid? A. Yes, I did. I saw them treat 5 or 6 wells, I should say, during that time.

Q. Can you recall at this date whether or not any of the tanks, the interiors of which you inspected, were any of the tanks that you actually saw at the well site when Chemical Process was treating the well with acid? A. Oh, yes, yes, a number of them.

Q. Did you ever have occasion to examine at very close hand the interior of any of these steel tanks of the Chemical Process Company to ascertain whether or not there was any metal other than the bottom of the tank in those tanks? A. Yes, sir, I did. That was the principal object of my going to these wells, was really to ascertain, if possible, what, if anything, was on the inside of those tanks, and when the tanks would be pumping their contents into the well I would be standing on the runway—there is a runway, Your Honor, that is a part of the truck equipment on which you can stand, and you could look into that manhole. It would be open, naturally, to let the air come in as the fluid was withdrawn. And I stood there on each of those trucks and watched them unload in that way, and saw everything I could.

Q. What, if anything, could you tell by these observations as to whether or not there was any metal in those tanks other than the bottom metal piece of the tank? A. Well, in some instances I couldn't see anything other than that. But in other instances I saw certain objects, not a part of the tank itself, lying in the bottom of the tank.

Q. Did you have occasion to examine very critically and at very close hand, such as being in these tanks, to

determine whether there was a[ny] metal other than the bottom part of the tank in those Chemical Process tanks? A. Yes, I did. I could not, of course, enter the tanks while they were in the operation right there. I could see in some instances material in the bottom there which appeared to be lead. I couldn't absolutely say that it was, because I didn't have my hands on it, although I was as close from where I am sitting, almost close enough that I could reach it, but those same tanks, later, after they were put back in the company garage in Odessa, I had occasion to examine that material very closely.

Q. Did you ever obtain any samples of that material? A. Yes, sir; I did.

Mr. Conner: I ask that that piece of lead be marked as PX-317 and the tag as PX-317-A.

(The articles referred to were thereupon marked PX-317 and 317-A.)

Mr. Conner: Mr. Lewis, I show you a piece of lead, or what appears to be a piece of lead, and ask you if you have ever seen it before? A. Yes, sir; I have. I can identify it by virtue of certain inscriptions that were placed on that piece of lead by myself. Right near the top, beginning is the date 7-24-39, which indicated the date that this sample was obtained. And underneath that is the word "Truck No. 65." Underneath that is the license number, which is 60-814. That was a Texas license number. And underneath that are the initials "C. P. Co." which was to stand for the name of the company, Chemical Process Company. And the last part of the inscription is my own initials, J. R. L. That inscription was put on there by me the night of July the 24th, 1939, or the early morning hours, possibly, of the morning of the 25th.

Q. And you obtained that sample from the tank and license truck as indicated? A. I did.

Q. I hand you PX-317-A and ask you if you can identify and tell what it is, and please read it. A. Yes, sir; I can identify this card. It is a card that I myself wrote certain notations on, with reference to the sample

you just handed me, sample of lead. It is in my handwriting. I will read it. (Reading):

"This sample is a piece of sheet lead about 3/32 of an inch by 4 inches by 9 inches that was taken by me from the roll of the same material found in truck tank of Chemical Process truck No. 65, Texas License No. 60-814 at about 12:00 o'clock midnight on the night of July the 24th, 1939. The tank was about ½ filled with water and was sitting in what appeared to be a repair shop of the Chemical Process Company at Odessa. This truck delivered acid to an unknown well that day.

"Signed J. R. Lewis."

Q. Does this identifying card have any indication as to the size of the lead plate from which this sample was taken? A. There is no comment on the identification tag about that size, but stating from memory there was a considerable roll of this material; it had been in the form of a sheet, apparently, originally, and it had simply been rolled up and just dropped into the bottom of the tank, apparently. It appeared to have been eaten away quite a good deal at that time, as will be indicated by the sample. I should judge that the roll of lead, at the time I observed it, would possibly weigh 20 or 30 pounds, in that instance.

Mr. Conner: I ask that the reporter mark the second sheet of lead as PX-318, and the identifying card as PX-318-A.

(The sheet of lead referred to was marked PX-318, and the card referred to was marked PX-318-A.)

Mr. Conner: I hand the witness what appears to be a piece of metal and ask if it likewise came from any tank of the Chemical Process, and if so can he tell us from what tank? A. Yes, I recognize this piece of material as a piece of what appears to be lead obtained by me from another of the Chemical Process Company tanks at Odessa on the night of July 25, 1939. I identify this by an inscription placed on it in my own handwriting, "July 25, 1939." Underneath is "No. 60-815," the latter number identifying the Texas license number of the truck from which the sample was obtained.

Q. I hand the witness PX-318-A and ask him to state what it is and what connection it has with PX-318, if any? A. This is an identification card bearing an inscription in my own handwriting that I attached to the sample at the time the sample was obtained, and the notation on this card reads:

"This sample is a piece of sheet lead about 3/32nds of an inch by 3 inches by 6 inches that was taken from a large piece about 28 inches by 36 inches by 3/32nds of an inch found in the bottom of Chemical Process Company truck tank about 2:30 A.M. on the morning of July 26, 1939."

I think that occurred in this way, I marked the lead as soon as I got back where I could, and the identifying tag was written the following morning after daylight, and that is the reason for the difference in the two dates.

"The truck has Texas license number 60-815 and was the same truck that was one of seven delivering acid to Texas County Well No. 1-D, Mallet Land & Cattle Company Labor 15, League 52, Hockley Co., on July 24, 1939, at which time I observed it to have lead in the tank. Signed J. R. Lewis."

The Court: I understood you had seven of those tanks for one well? A. Yes, sir.

Mr. Conner: I call the witness' attention to the inscription that is on the reverse side of the last lead plate and ask if he knows what that inscription is, or if he had anything to do with it. A. There is an inscription on the opposite side of the lead from which I read a moment ago, two, as a matter of fact, both of them reading "T-6"; that is an inscription that I had nothing to do with and have no knowledge as to what it indicates.

Mr. Conner: I will state for the record that that inscription "T-6" was my own inscription for the purpose of keeping track of some samples I had.

I ask the reporter to mark the third lead plate as PX-319, and the accompanying tag as PX-319-A.

(The sheet of lead referred to was marked PX-319, and the tag referred to was marked PX-319-A.)

Mr. Conner: I hand the witness PX-319, comprising what appears to be a piece of lead plate, and ask if he can identify it, and if so how? A. I can identify it not only because of the inscription that appears on it in my handwriting, but because I remember the particular piece of lead quite well. The inscription is dated August 11, '39, truck 77, license 60-818, trailer license No. 12-574. Initialed J. R. L.—my own.

Q. Is that the piece of lead that you obtained from a tank of the Chemical Process Company? A. Yes, sir, I obtained that piece of material from the tank on Chemical Process Company's truck No. 77, which bore Texas license number 60-818, and a Texas trailer license number 12-574.

Q. I hand the witness PX-319-A and ask if he can identify it. A. Yes, sir, this is the identifying card on which I made a notation at the time that sample was taken, or shortly thereafter. The notation reads:

"This sample is a piece of sheet metal, apparently lead, on which I have inscribed the date of August 11, '39, truck No. 77, and other data to identify it. It was cut by me from a large roll of similar material found inside tank on Chemical Process Company truck No. 77, Texas license number 60-818, trailer No. 12-574, at about midnight, August 11, '39, while truck stood half full of oil coated water at the company garage. J. R. Lewis."

Q. Have you any recollection at this time as to the size of the piece of lead from which you cut the lead represented in PX-319? A. Very distinctly, yes. The size of that, that was the largest of all of these that I examined, it apparently was a nearly new roll; it had not been eaten away very much, as is shown by the sample itself. In my best judgment, the length of that roll was perhaps 28 to 32 inches. It was under water, of course, and I can only estimate it, I did not measure it; and in circumference it was perhaps 10 or 11 or 12 inches in circumference, and apparently had been rolled about once and a half or two times, from which in my—I estimated from those characteristics that spread out it would probably be a sheet of lead about

28 or 30 inches square, and perhaps 3/32nds of an inch thick, more or less.

Q. After obtaining these pieces of lead represented by PX-317, 318 and 319, what did you do with them? A. I marked them as has already been shown, and thereafter I either gave them to you personally at a meeting between us in Amarillo, Texas, or I may have mailed one or more of them to you at Tulsa, Oklahoma.

CROSS EXAMINATION

By Mr. Lyon:

Q. Did you go to the well on these occasions on the truck with the driver? A. In some instances I did, yes, sir, and in a few instances I drove my own car.

Q. Did you keep any record of this investigation? A. Well, I made certain notes and reports almost every day to Mr. Conner there, but I mailed those in to him.

(These reports were produced later and submitted to defendant's counsel.)

Q. How did you get invited by, or arrange with the driver to let you ride on those trucks of the Chemical Process Company? A. Just as I explained a little bit ago, I simply indicated to them that I was interested in learning the manner in which they treated these wells, and what effects were obtained by the treatment.

Q. What was the driver's name? A. One of them is all I remember, one of them was a Mr. Jackson.

Q. What was his first name? A. I don't happen to know at this time. They called him "Jack."

Q. Is he the only driver that you rode with, that you ever rode out with. A. I believe he is the only one I actually rode with. Of course there were others.

Q. What did he look like? A. Oh, he was a large man; he would weigh about, perhaps 180 pounds; I judge him to be about 33 or 34 years old, dark-complexioned, a very good looking man.

The Court: How did you get in there and cut that lead off? A. I had a pair of large tin snips, Your Honor.

The Court: Well, was it right near the manhole? A. No, sir. That last piece there, that is the reason I remember that one so well. It was clear up in front of the truck, and I had to crawl in there and even get down underneath the water and pass under a partition in the middle of the tank before I ever succeeded in finding the lead at all.

The Court: How much is lead worth a pound? A. In that last roll there, which was apparently a new roll, I would judge that roll to have at least a hundred pounds in it.

The Court: How much is it worth a pound? A. I have no idea.

The Court: How much did you cut off, all told? A. Those were the approximate sizes of the pieces.

The Court: How many pieces did you take from this company? A. Only those three. Those are the only three pieces of lead that I recall obtaining.

The Court: Inside a building? A. Inside an open garage; yes, sir.

The Court: Did you see any trucks that didn't have any in? A. Yes, sir. I saw some trucks that I couldn't see any in from the outside. I wasn't on the inside of any truck that I didn't find lead in.

The Court: And you were—you only got into three trucks? A. I believe so, yes, sir.

Mr. Lyon: How many trucks did they have? A. They had—there are stationed at Odessa eight or ten, perhaps more than that, but they had another base over in New Mexico and sometimes the trucks from New Mexico would come over to some of the Texas wells.

Q. Did you look in these other trucks? A. Yes, sir. I looked at every one I got a chance to.

Q. Did you look in all of them? A. I wouldn't say that I did, because there are some of them that I may not have had a chance to look in.

Q. How many of them did you look into? A. I would say I looked in at least ten.

Q. In these three that you found the lead that you

took the samples from, was that lead just in there loosely, or was it attached to something? A. Didn't appear to be attached to anything; just lying in the bottom of the tank.

Q. Just rolling around in there? A. It wasn't rolling very much, because the roll wasn't completely round. It was somewhat oblong and I imagine it would slide, but I hardly think it would roll very much.

Q. Now, you said that in these samples that weigh about twenty pounds—one of these rolls had about twenty pounds. A. That was in the first truck, yes.

Q. Just show us with your hands about how big a roll that was? A. Well, it was a roll, I would say, closely approximating the little machine sitting on the reporter's desk there. It was not a solid body, you understand, but it was rolled to where the over-all dimensions would roughly approximate that little machine.

Q. And was it rolled up in a spiral? A. Yes, sir.

Q. How many rolls of it? A. Well, I would say one and a half to two turns in the spiral.

Q. Now, did you notice whether or not there was any connection made between these tanks and the casing in the—or the piping in the well when the cementing operation went ahead? A. Yes, sir, I saw a number of the tanks hooked up by portable connections.

Q. I mean, did they have any wire to connect the tank, or any cable to connect the tank to the pipe? A. Well, I am not certain that I understand the question. Do you mean some kind of cable through which fluid would pass?

Q. No, like a cable to carry electric current? A. I didn't see any such cable as that. I heard some comment about it. I looked as far as opportunity was afforded but I didn't see any.

My instructions for making this investigation were oral. Mr. Conner gave them to me and I made reports to Mr. Conner. They were not extensive reports. They were more or less just informal memorandum reports. I did not report every day. If there was nothing to report no report was made; during that period of time, oh, perhaps a dozen

letters written. This is the only investigation I ever made for the Dow Company or for Mr. Conner.

The Court: Just this one job at Odessa? A. That is right. I wasn't at Odessa exclusively in this particular job but there most of the time, and it's the only one I did for them.

Q. Where else did you go? A. Well, I was at Breckenridge.

Q. What did you find at Breckenridge? A. I only stayed there part of one day. I merely found some storage tanks out there. I don't know what they had in them but nothing of any significance, in my judgment, was laying there.

Q. Where were they? A. They were down in a section of the town sitting near the railroad tracks, Your Honor.

Q. Why didn't you crawl in them? A. Well, those tanks, in the first place it was in daylight, and they were plainly exposed to view; and in the second place, if they had acid in them you couldn't do it.

Q. Well, was there acid in them? A. I don't know.

Q. Why didn't you go at night and find out? A. Because I had been instructed that most of the expected results were to be obtained at Odessa.

Q. What did you go there at all for, then? A. Breckenridge happened to be the home town of the owners of the Chemical Process Company.

Q. It's just as much night there as it is any place else, isn't it? Get just as dark? A. That's true, but Breckenridge was right enroute between Tulsa and Odessa anyway. I was instructed as I passed through there to look over the situation and see if anything that appeared to be of interest—

The Court (interrupting): Did you make out a bill for your services? A. I don't believe I did. I made out some expense accounts. I don't believe I made any bill other than that.

Q. And they would give you your expenses, wouldn't they? A. Yes.

Q. Who gave you your furlough? How was that arranged? A. Arranged by my superior in Washington.

Q. Did you get that as a result of this employment? Did you plan as your vacation to get this employment because you had secured the employment? A. The circumstances were these—I hadn't had a vacation in nearly five years in Government service. I was going to take leave anyway. I discussed with my superior in Washington the possibility that I might secure or accept a permanent employment with The Dow Chemical Company. I wasn't certain whether I would like the employment or not in any event, or whether it would be offered in any event. He very graciously permitted me to have the opportunity of going out and undertaking this one assignment with the view that if I liked the employment and it represented advantages to me that I would sever my connections with the Government. And, on the other hand, if I wanted to come back, my job would be waiting for me when I came back.

Q. Where were you when you made this arrangement? A. In Washington at the time.

Q. What were you there for? A. In connection with some cases for which I had been called to Washington for a conference.

Q. Anything in writing about your furlough at all? A. I am sure there is, Your Honor.

Q. Didn't you get any letters about it or write any letters about it? A. Yes, sir, I wrote some letters to my superiors forecasting this possibility.

(The correspondence between Mr. Lewis and his superiors was later produced and submitted to the court.)

Mr. Lyon: Do you have a Government badge? A. Well, I don't have a badge, I have an identification card. I have never had a badge.

Q. Did you use that identification card at all in connection with making any contacts with the Chemical Process Company's men? A. Not whatever.

Q. How did you make your contacts? A. Simply by word of mouth.

Q. Well, were you given permission to go into their garage at night and crawl inside their trucks and cut off pieces of lead out of their tanks? A. No, sir.

Q. They didn't know you were doing it? A. I don't think so.

Q. When you rode out to the well did you tell them you were interested in whether or not they had anything in their tanks? A. Yes, sir, but I didn't tell them why I was interested.

Q. Did you ride out with more than one driver? A. I don't think I ever rode with any one except Mr. Jackson.

Q. How many trips did you make with him? A. I think as many as two, maybe more than that; I would say not less than two, though.

Q. Not less than two, it could be only two less than two; how many did you make, or don't you know? A. No, sir, I don't know how many times I rode with Mr. Jackson.

Q. How many wells did you go out to? A. Well, I went to several; I remember the one up on the Mallet Land & Cattle Company very well, I remember going to two different locations down in Upton County, and I remember going to one, and perhaps two, on the Gulf leases right on west of Odessa, I have forgotten the name of the leases out there.

Q. Did you ride on the Chemical Process truck? A. No, sir, I think I went with my own car all of those times except that I believe I rode with Mr. Jackson when I went up to the Mallet Land & Cattle Company, and it is my recollection that I rode on one other occasion with him, but I can't say at this time which of the other occasions it was.

Q. Did you give Mr. Jackson your name? A. I gave him a name, yes, sir, I didn't give him my—

Q. Did you give him your same name you have given in court? A. No, sir.

Q. What name did you give him? A. I told him my name was Paul Jackson.

Q. His name was Jackson, wasn't it? A. It just happened, that was one of the bases of friendship.

Q. Where did you tell him you were from? A. I told him I was from Kansas, as I recall.

Q. Were you from Kansas? A. I had been in Kansas.

Q. Were you at that time? A. No, sir, I was not in Kansas right at that time.

Q. Did you meet anybody else connected with the Chemical Process Company there in Odessa except Mr. Jackson? A. Yes, sir, not to say meet them, I wasn't formally introduced to anybody else, I don't believe.

Q. Did you give your name to any other representative of Chemical Process Company? A. Well, I didn't give it to them, but I was known among all of the men that worked with Mr. Jackson there, I was known, if known at all I was known as Paul Jackson.

Q. Now, can you name some of the other men that knew you by that name at that time? A. No, sir, I couldn't, because I don't remember the names of anybody else there.

Q. How many other men did you meet, if you met any? A. Well, I didn't meet any of them formally, as I said, but I think there were seven or eight other men there that I had a speaking acquaintance with.

Q. You didn't make any arrangements with the people to let you hang around watching what they were doing? A. Not other than what I have told you; they seemed to be entirely willing to permit me to do so; of course I made—

Q. They didn't seem to be trying to hide anything or keep any secret? A. Well, I couldn't answer that just that way. If you want to know what it seemed to be, I will be glad to tell you.

Q. I am trying to find out from you on what pretext they would allow you to stay there if they were trying to cover anything up. What pretext did you use? A. Well, the pretext that I used was just as I have stated, I told them that I was interested in learning all I could about treating wells and that I knew nothing about it and it was more or less a new undertaking, apparently, in the oil business, and apparently, very excellent results were being obtained, and that I certainly wanted to know all I could about it.

The Court: Have you ever done any of this kind of work before? A. No, sir. I had worked for a unit of the Standard Oil Company there, but was an accountant more or less by profession at that time.

Mr. Lyon: That investigation that you made in July and August of 1939 for Mr. Conner and the Dow people, is that the only investigation that you have ever made outside of your work for the Department of the Interior? A. Well, I have worked with various state agencies a good many times.

Q. This is the only private work that you have done? A. Yes, that is right. The only private investigation that I have made.

Q. Did you investigate anything or anyone aside from the Chemical Process Company? A. Only very nominally; I made some casual inspections of the facilities of Mr. Beard, I think it was, down in McCamey, Texas, and I made some examinations of some of the Halliburton activities during this same time.

Q. Did you crawl into any of the Halliburton tanks? A. No, sir.

Q. And cut off any pieces of anything? A. No, sir. I was never on the Halliburton property, I was never upon any of those tanks, or where you treated a well. I merely went up where they had their business, where they kept their trucks and stored their acid, and so forth, where they kept their trucks stored and their acid stored; I was up there a good many times and observed the truck movements, but that was as close as I ever got to any of the Halliburton activities.

Q. Was that at the request of Mr. Conner? A. Along the lines of his general instructions.

REDIRECT EXAMINATION

Mr. Conner: Last Friday we had Mr. Lewis on the stand, and I will recall him and have him show you what correspondence he has relative to his leave of absence from

the Government to do the temporary work he did in July and August of 1939 for the Dow Chemical Company.

Mr. Conner: Mr. Lewis, will you please show to the court whatever corresponce it was that the court asked for, relative to the leave of absence that you obtained from your agency in 1939? A. Yes, sir.

(The witness exhibited a file of correspondence to the court, and the court examined the file.)

The Court: I have looked at the correspondence between the witness and his superior and Mr. Conner up to the time the leave was granted. It is quite a file. I have not looked at the balance of it, which he says was with Mr. Conner. I will just say this on the record, that the portion I read seems to fully corroborate what the witness said about the leave he obtained, it seems to be regular and proper, and the leave seems to have been a regular and proper leave. I do not see anything to criticize in the way that he obtained his leave, and the way it was granted. It all seems entirely regular. But I have not looked at the other part. Counsel may look at the balance if they desire. I have not. I do not know what he has written back and forth to Mr. Conner, because, as I say, I did not go into that. He has a big file there about it. It often happens that it is better to show things than not to, because they look better when you see them than they do when you use your imagination.

Mr. Conner: I have my file here, which is my correspondence with Mr. Lewis and his reports to me, which I will submit to counsel.

The Court: I think that you have fully complied with my request, and I will say that that part of it does not look bad at all. It is all regular and proper, as far as I can see. The man is ambitious, and wants to work. I am not discussing any of his relations with you at all, but so far as his obtaining his leave of absence, and he is very frank in what he said about getting it, and they were very frank, that he was entitled to the leave of absence and got it; and he was entitled to do what he wanted to do when he was on

leave. So there is nothing that reflects on the witness or the Department. It is all regular in every way.

Mr. Lyon: May I see both files?

Mr. Conner: You can see both files. I have no objection to the defendant seeing Mr. Lewis' file. I am saying now I have seen that, and I think this is a much more complete file, and this letter here, I think (indicating) is the one you were looking for. There were some acid samples.

(Mr. Conner hands file to Mr. Lyon.)

Mr. Conner: Your Honor, Mr. Lewis has produced his file at Mr. Lyon's request. I have asked Mr. Lewis to take out of his file some three letters here (handing same to the court) which have nothing to do with reports he made to me. They are somewhat in the form of personal letters. I have no objection to your seeing them. But, specifically, they have to do with a man we hired later, and I do not care to have his identity disclosed, but I am, of course, only too glad to have you look at the letters and determine their relevancy.

The Court: This is something you took out of your file?

Mr. Conner: No, sir; they came from Mr. Lewis' file.

The Court: I haven't read those; I am thinking about it.

Mr. Conner: I have copies of some of those which I took out of my file, too; yes. These are letters written afterwards, after this gentleman left our service, and I am asking him by mail or by phone or what not, we had two or three letters back and forth, where we were discussing certain people I had intended to hire, and I did hire one of them later, and it has nothing to do with these samples that Lewis obtained in this month of July 15 or July 13 to August 15, and I don't care to have those fall into the hands of defendant unless the court thinks it is material to this case.

The Court: Are they in chronological order here? A. The one in longhand is Mr. Conner's letter.

The Court: Well, to sum that all up, all it amounts to,

it suggests a name to carry on his work. That is what it gets down to; it would reveal the name of somebody that is recommended.

Mr. Conner: I think there are two men mentioned in there and one of them we did hire.

The Court: That is the only object, isn't it? I don't see as that would have anything to do with the other; it is a discussion about whether or not he would accept what you offered him for the future to leave the Government service and take up work for the Dow Company, but the only thing they object to, and the only thing it would add to what you already know is the names of those parties, and I cannot see any relevancy.

Mr. Lyon: I have two files here, one which was handed me by the witness and one which was handed me by Mr. Conner. Is the file you gave me your complete file of all your correspondence and reports on this matter so far as you have them? A. Yes, sir, that is true.

Mr. Lyon: And is the same thing true of your file, Mr. Conner, or has something been taken out of it?

The Court: There were two letters in here, copies of letters you had written, or somebody? A. That is right, they are merely extra copies, Your Honor.

The Court: Then they are complete except—that (indicating) didn't come out of your file, did it? A. Yes, sir.

The Court: The longhand letter came out of your file? A. The longhand letter came out of my file, that was his longhand letter to me.

The Court: And your reply to him? A. That is right.

The Court: That is all that are out of your file? A. That is right.

The Court: I have already told you what they were; I have told you everything except the names of those two men, and they do not mean anything to me, but that is all the added information you would get out of reading that from what you now know.

Mr. Conner: Mr. Lyon asked me if my file is complete on my correspondence with Mr. Lewis. It is, with the ex-

ception of these letters I have taken out (indicating). This I think you have seen the copies of, and this longhand letter, the original of it, I don't know whether you have seen this or not (handing documents to the court).

The Court: No, I haven't.

Mr. Conner: But it is in longhand on the same subject, and with that reservation my file is complete.

The Court: Well, that longhand letter by you to Mr. Conner, as I understand it, doesn't discuss this same man, or is that another man? Is that the same man?

Mr. Conner: I don't remember, I believe it does.

Mr. Lyon: This correspondence, Your Honor, in both of these files is in longhand. It is not typed, and I am unable to check one file against the other. For instance, I find in Mr. Conner's file copies of letters and apparently copies of letters to Mr. Lewis that I do not find in Mr. Lewis' file.

Mr. Conner: I cannot explain that. It is in longhand writing because I do practically all of my work in longhand, and once in a while I get it typed, but I am old-fashioned.

Mr. Lyon: For instance, Mr. Conner, the top letter in your file, one of the top ones, is dated September 22nd to Mr. Lewis, and I do not find it in Mr. Lewis' file.

Mr. Conner: This letter of September 22nd in longhand to Mr. Lewis is an original pencil letter which I sent to Mr. Lewis and at the time of sending it I retained the carbon copy of this longhand letter dated similarly, and I asked Mr. Lewis certain questions which he answers herein, as indicated by the red ink notations, so this letter, the original in pencil, went to Mr. Lewis; I retained the copy which you see here, and this, the original letter, (indicating) he sent back to me by way of answering my letter, putting those notations on it.

Mr. Lyon: Well, you evidently had been just—just glancing through this correspondence in a hurry, you evidently had considerable trouble in obtaining samples at the wells of the truck acid, is that correct? A. Well, not exactly trouble, no, sir; we had some difficulty in getting samples from each of the different trucks; we didn't have any dif-

ficulty getting some samples, but the difficulty was in getting it from the different trucks.

Mr. Lyon: Then after you had gotten them and sent them to Mr. Conner, or up to his company, it appeared that there was some confusion as to which samples came from which trucks? A. Well, that was particularly true with reference to one sample obtained by my man Lane.

Mr. Lyon: Now, you didn't tell us the other day, but it appears from this correspondence, that the Chemical Process Company were using rubber-lined transportation trucks? A. They had one truck that was rubber-lined; I didn't tell you about it; nobody asked me about it.

Q. And you took samples from that truck and forwarded those? A. Nearly all the samples obtained were from that truck. I wouldn't say that they all were but you asked me if there was any I don't think the question was ever answered but you asked me if there was an attempt made by any one to conceal anything at the wells there. The fact is every time they gave us a sample, with the exception of maybe once or twice, it came from the rubber-lined truck.

Mr. Conner: You mean the acid samples? A. That is right. Acid samples.

Mr. Lyon: Well, Your Honor, I don't like to hold this up while I study these files. If the files could be available, if there is any further evidence on this matter, why that would satisfy me.

The Court: I will put this on the record—that this gentleman left the service of Dow before he completed his work. I got that from what I read. That he terminated his employment with Dow before he completed all they wanted him to do because the Government needed him, and the time had arrived when he had to go back to work. That grew into his recommending this other man.

Mr. Conner: I don't believe Mr. Lyon will mind my stating on the record that Mr. Lewis' expense account shows the first date of July 14th and ran through August 14th. And that was the period that he was in our employment, and we paid him for one month.

JAMES W. REBBECK,

a witness called in rebuttal by plaintiff, testified as follows:

DIRECT EXAMINATION

Mr. Owen: Have you prepared a chart which shows the different acids that are corrosive to iron or steel, and also other data regarding the materials called for in the Gravell patent? A. Yes, sir, I have.

Mr. Owen: I will offer this chart in evidence as PX-337.

(The chart referred to was thereupon marked PX-337.)

The Court: Taking the Gravell patent for what it says and what it claims, it seems to cover any kind of a material that you put in that will put a coating on the iron and protect it against corrosion, doesn't it, to take in what it tried to cover.

Mr. Owen: I believe that is true, Your Honor.

The Court: And, again, right over, if used in a container for storing or transporting?

Mr. Owen: Correct.

The Court: I go right over to the Grebe patent, and that attempts to cover any kind of an inhibitor that will prevent acid eating iron if used in acidizing a well.

Mr. Owen: That is right. That is, if used in hydrochloric acid.

The Court: In hydrochloric acid.

Mr. Owen: And some of the claims are not as broad as that, because they call for—

The Court (interposing): And, in the broad sense, anything that inhibits puts a slight coating on the iron, and that is the way it protects it, and I run right around in a circle there that you have both attempted to get a patent for narrowing down to the subject we are dealing with, with the Grebe, if you put anything in hydrochloric acid for the purpose of storing it in a tank or transporting

it, which will put a coating on, namely, inhibit, the two seem to go together, one putting a coating on to inhibit, and then inhibiting by putting a coating on, they seem to cover the same thing, the patent says if anything is put in which inhibits, namely, it is described by putting a coating on, a hydrochloric acid solution with an ion, if used in a tank or transporting container made of iron, and Grebe describes the inhibitor, which means putting a little coating on, that if hydrochloric acid is used with the substance which will inhibit, namely, put a little coating on, in acidizing a well, it infringes. It seems as if they were both intended to be that broad.

Mr. Owen: I think you are right.

The Court: And they simply describe—one describes inhibition in the language of putting a coating on, and the other describes putting this little film on in the terms of inhibiting.

Mr. Owen: Well, Your Honor will—

The Court (interposing): I don't know, it seems as if it is a fair analysis of those two patents, and, so far as validity is concerned, as if these nice refinements, while they are interesting and probably necessary to an understanding of it, it seems as if whether I am thinking right now about the—well, both on validity and infringement, if that is what they intended to do, what they claim by it, they each claim that the other can't get away from their patent by anything new that I can think of discovered, when it comes to interpreting it on infringement, for the sake of getting away from infringement, it is a different bed, but, so far as the owner of the patent is concerned in claiming infringement, he claims that broad interpretation and he turns around and tries to narrow the scope of the patent in defending against infringement.

Isn't that about the—well, anyway, I just thought if anyone saw that that was a faulty thought there I will give you a chance to puncture it.

Mr. Owen: The only modification I would make of it or suggestion of a modification is that while both of the

patents do include broadly the use of an inhibitor, whether it be a metallic inhibitor or a non-metallic—

The Court (interposing): —or a combination—

Mr. Owen (continuing): —or a combination, that that is only one of three broad and undefined branches of the Gravell claims. In other words, they not only claim the use of any such inhibitor but they claim it with the use of any kind of an acid, and they claim at least ten different classes of metals in combination with hundreds and thousands of different non-metallic substances, whereas the only charge of undue breadth—if you might so call it—in the Grebe Sanford patent, is the one thing, and that is inhibitors. The acid is specified and in some of the claims the particular strength of the acid is specified. And we will show, Your Honor, that that has something to do with the importance of this invention and with the success of it. So that I hardly think the two patents should be placed in exactly the same status.

The Court: Well, I am thinking particularly about the difference of one describing it as a film placed on the iron to protect it and the other describing it as an inhibitor. That is another way of describing the same thing.

Mr. Lyon: Your Honor has suggested if we had anything to add or emphasize, I would like to emphasize in connection with Your Honor's statement, not in contradiction of it, but in connection with it, that insofar as the idea is concerned or establishing is concerned of the idea, that an inhibitor could be used with a corrosive acid and would protect a steel container so that acid could remain in it, in contact with it for periods of time without substantial injury to the container. That idea is in the Gravell patent, which is four years earlier than the Grebe-Sanford patent. So I think that as they both use that same idea of one to protect a transportation tank and containers, and the other to use that idea as applied to a pipe in which you are transporting acid, it seems to me Your Honor should bear in mind not that these Gravell and Grebe-Sanford patents are of the same date and therefore entitled to the same

consideration but you should always remember that Gravell is prior to Grebe-Sanford and that Grebe not only borrowed from the entire prior art but he had Gravell to borrow from.

Mr. Owen: Well, I have already pointed out that our contention is that the Gravell invention was not directed to any such use as the plaintiff makes of protection to the tanks and the well tubing; that the Gravell invention was directed to solving the problem of storing and shipping acids in unprotected steel for indefinite periods.

The Court: They needed a better inhibitor to do the job.

Mr. Owen: You go to this Fawcett article that was discussed this morning and there Fawcett was endeavoring to provide an inhibitor which would make less corrosive 66, or practically 66 degree Baume sulfuric acid, which under the Interstate Commerce rules may be shipped in steel. Fawcett recognized that even though it is shippable under the regulations that there is danger in doing it. Gravell was seeking to solve that same problem and Gravell, as a matter of fact, did not solve it any better than Fawcett solved it.

The Court: But he would really need a better inhibitor.

Mr. Owen: Very much.

The Court: You could get along in Grebe's with a poorer inhibitor than Gravell's.

Mr. Owen: Oh, yes.

The Court: Because they were planning to keep it for a long time, a much longer time.

Mr. Owen: Yes. Our contention is that Gravell did not solve the problem that he disclosed in his patent.

The Court: And he was dealing with, not only to danger, but danger to life, which you are not dealing with in Grebe.

Mr. Owen: That is true.

The Court: So he really, in order to solve his problem, he should have had a better one, but that does not help Grebe, that thought right there.

Mr. Owen: Well, I think that it does, but I do not want to argue that now. I think that you have got to consider a patent in connection with the use to which the invention is intended to be put.

The Court: I was just thinking about the difficulty of accomplishing the result, the result desired, and that is all I meant. I do not mean that it is more difficult to think of. I mean it is more difficult to get an inhibitor—it would take a better inhibitor to do well what Gravell had in mind doing, than it would to do what Grebe had in mind.

Mr. Owen: That is true.

The Court: I think that the reason I reached that conclusion is for two reasons, and one is that Gravell coupled not only the destruction of property and losses of that kind, but also the danger to life, which always is greater than the loss of property. the way my scales weigh things. I am only talking about the difficulty of getting an inhibitor that would do the trick, and I say that required a better one to protect life, and for long storages, than it would for an inhibitor that would protect the pipes of a well. That is entirely independent of the difficulty of thinking of it, and the ingenuity required to think of it.

(By Mr. Owen): Reference was made at a recent session to a statement contained in the file history of the Grebe and Sanford patent which counsel for the defendant urged as an estoppel against a construction of the Grebe-Sanford patent which would include the use of metallic inhibitors. Are you familiar with that file history, and if so, will you discuss that portion of it?

Mr. Lyon: If Your Honor please, I object to that. The file history is a document the court is called upon to construe, and its legal effect is a matter of law entirely. I do not believe any witness can change or modify or testify as to what the legal effect of the situation in a file history gives, and I certainly do not believe that we should take up the time of this witness discussing something which is purely a matter for the counsel to present to the court and for the court to rule on. He cannot change those facts, add

anything to them one way or the other by anything he says.

The Court: He might interpret some language there, if it was technical along his line, that wasn't technical along legal lines.

Mr. Owen: Well, this witness is a chemist, Your Honor, and I am not.

The Court: Well, I generally, most of it falls over into the class that Mr. Lyon has described, in the field of the lawyer, but there may be some of it over into the other field, in the way of interpreting the language and the meaning of it, so I will let it in. You may go ahead.

A. In the first place, when the Grebe and Sanford application was filed June 30, 1932, according to the record of the file in that application there were claims in the application reading as follows:

"In a method of increasing the output of a well for producing a fluid mineral product such as oil, gas, water or brine, the step which consists in introducing into the well an aqueous hydrochloric acid solution to which has been added a relatively small amount of a corrosion inhibiting agent."

Of course there were other claims in addition to that one, but that is a typical broad claim insofar as the corrosion inhibiting agent is concerned.

Mr. Lyon: Now, if Your Honor please, the witness is not testifying to anything technical, he is not giving you any information as to the meaning of anything, he is just making an argument here, a legal argument.

The Court: I agree it is 95 per cent of the kind you describe, but we will go ahead with it.

A. That was the type, one type of claim that was in the application at the time it was filed, insofar as it concerned this corrosion inhibiting agent about which I have something to say on the technical side, and I point out that that was the language of the claim when the claim was filed, and it refers to certain types of chemical things.

Now, to go back to the time following that, when there was either an action by the Patent Office, or a response by

the applicant's attorney; at first, however, under date of July 30, 1932, there was an amendment prior to examination which affected the language of the claim I just quoted so that it was amended and as amended, it cancelled the term "a corrosion inhibiting agent," and substituted therefor "an agent capable of inhibiting the action of acid on metals." That is of course substantially the same chemical agency, but in somewhat different words. Some of the other claims were similarly amended, but apparently not at that time.

The Court: How did that change it? A. I do not see that that changes the scope of the claim in the least bit insofar as the choice—

The Court: If it did, I didn't get the meaning. A. It doesn't change the choice of chemicals to be used in the process at all. It was just another form of language for the same thing. At the same time as this amendment prior to the office action two other claims were presented, the specific feature of these being in connection with the process, the incorporation in the acid of an organic nitrogen base as one of the inhibiting agents, in an organic sulfur compound as another, in the two claims respectively that were thus added. And the remarks that accompanied that amendment were as follows:

"The foregoing amendment to the specification is for the purpose of correcting and clarifying the text in certain details. The new claims added are of similar scope to claim two that reads to two additional species. Claim 1 is to be regarded as a generic claim and claims 2, 10 and 11 read to the three selected species in accordance with rule 41."

And then an office action was mailed from the Patent Office on August 8, 1932, in which a number of references were made of record. Now, the Examiner made the rejection of Claim 1 and some of the others, on Ranney et al., 1,806,499, the Examiner stating, "—who carries out all steps of the process except that he makes no mention of using inhibitors."

The Court: Ranney, you said, did describe all the

uses except inhibitors? A. That is what the Examiner says. I don't think that Ranney went that far.

The Court: Ranney did not use it in a well, did he? A. Ranney did not use any inhibitor in the well, and he did not carry out the acidizing of the producing formation, as I recall that particular patent.

The Court: They haven't yet found that old 1896 one at all? A. Not yet, no.

Mr. Lyon: They never cited that at all in the Patent Office. It was mentioned in the specification, but the Examiner never referred to it. A. It was referred to by the patentee in his specification. So there was no point in the Examiner citing that. It was already of record. The Examiner goes on to state, (reading): "However, the use of chromates and mud fluids as inhibitors is suggested in the book on petroleum development and technology, and also in Bulletin 233 of the Bureau of Mines. The use of mud as an inhibitor is suggested by Lake, et al."

Then the Examiner goes on to state, (reading): "Furthermore, any dissolved chloride would operate as an inhibitor by suppressing the disassociation of the hydrochloric acid, and such chlorides would inevitably be present."

He continues (reading): "In view of the foregoing considerations, it is not thought possible to draw any allowable claim which is not limited to some specific kind of inhibitor, and in the absence of any allowable generic claim, an election will have to be made between the use of arsenic, nitrogen and sulphur compounds as inhibitors. Division is therefore required between claims 2, 3, 4, and 6, claim 10, and claim 11."

Now, after that action by the Examiner, there was a response by the applicant to the Examiner's statement—(reading): "Furthermore any dissolved chloride would operate as an inhibitor by suppressing the disassociation of the hydrochloric acid and such chlorides would inevitably be present."

This response considers in considerable detail all the

references, and I might also point out that the Frasch patent is mentioned in this response, the language being, "The utility of hydrochloric acid treatment in increasing the flow of an oil well was first pointed out by Frasch in United States Patent 556,669, in 1896, but this method has never found general application due to the danger of corroding metal apparatus within the well."

And the argument continues that "Present applicants have found, and are first to find that any of a wide variety of inhibiting agents may be added to hydrochloric acid to prevent its attack upon metal surfaces within a well, and that the so treated acid may be employed to increase the flow of a well without danger of corroding metal surfaces within the same."

Mr. Lyon: I do not think this witness is adding anything in the form of fact testimony.

The Court: He is not doing any harm.

A. (Continued): Well, perhaps I am exhausting your patience a little, but I have to get the background here so that the language that is used here will be understood with reference to the connection. It can't be taken apart and reveal some meaning not intended by the party using the language.

Mr. Lyon: I move to strike that out. That is a legal opinion, not a fact the witness is permitted to testify to.

The Court: Motion denied. Overruled.

(Witness continuing): Since hydrochloric acid which contains a corrosion inhibiting agent does not attack iron, the acid, as pointed out on page 4, lines 15 to 17 of the specification, "can be introduced into the well through the pump tube so that the latter need not be withdrawn prior to the treatment." (reading from page 2 of response of 8-12-32): "Applicant's method, which is now being used extensively in certain oil fields, is advantageous over that described by Ranney in that applicants treat a well with aqueous hydrochloric acid which contains an agent capable of inhibiting the action of the acid upon metals within the well. Claims 1, 5, 7, 8, and 9 which were rejected on

Ranney, distinguish from the latter in specifying that the hydrochloric acid with which a well is treated shall contain such inhibiting agent." The response continues—"In the last Office action it is stated: 'The use of chromates and mud fluids as inhibitors is suggested in the book on "Petroleum Development and Technology" and also in Bulletin No. 233 of the Bureau of Mines.' This statement is thought to be incorrect. In lines 9-13 of page 497 of "Petroleum Development and Technology" it is stated: 'In fact we find that both the depth of pitting and the total amount of corrosion may be limited by the use of sufficient chromate. If an insufficient amount is used to inhibit corrosion the result would probably be a slowing down of average rate of corrosion by an acceleration of local corrosion in the form of pitting.'" From the photostatic copy which is available of the above reference it is not clear what type of corrosion is referred to or to what purpose the corrosion inhibitor is to be applied.

However, the reference shows clearly that a chromate cannot be applied successfully to prevent corrosion within a well, as it is perfectly evident that during pumping of the well the amount of chromate present would be reduced, but that a small amount of chromate would undoubtedly remain within the well and such small amount of chromate would increase the pitting of iron by corrosive agents. The above reference does not refer to the use of mud as a corrosion inhibitor.

"Bulletin 233 of the United States Bureau of Mines gives a full discussion both of the use of chromates in preventing corrosion of iron apparatus within a well and of the use of mud for similar purpose. The chromate treatment is described on pages 84 and 85 of said reference and consists in immersing the iron or steel in solutions of inhibitive agents such as solutions of chromic acid and of certain chromate and bi-chromate salts. Obviously, such treatment of iron apparatus must be carried out before the apparatus is placed within a well, hence the inhibiting agent, a chromate, is not employed along with an acid which

is to be introduced into the well. Furthermore, the reference specifically points out that such chromate treatment, when applied to iron apparatus which is to be used within a well, is useless as such corrosion inhibitor does not afford protection against chlorides or sulphates which may be present within the well."

And now we come more particularly to the language of the Examiner, and this portion of the argument, apparently, is coming to that, as I have already read, this last sentence, the last part of which refers to the chloride being present within the well, rather than in the acid which is introduced into the well. And I quote now:

"'The protection afforded underground equipment by chromate solutions is of doubtful value not only because the passive surface of the metals becomes scratched and worn away but mainly because the passivity is temporary at best, and is destroyed by chlorides and sulphates if present even in very small proportions in underground waters. A few hundredths of one per cent of a chloride or a somewhat greater proportion of sulfate appears to destroy the passivity afforded by chromate solutions. Chromate solutions may have special uses as inhibitors of the corrosion of surface equipment in the oil and gas fields, but for underground use in wells these reagents are believed to be useless.' The above quotation shows clearly that a chromate will not prevent corrosion of iron or steel by a chloride and this fact is particularly true if hydrochloric acid, which is known to be highly corrosive to iron and steel, is the chloride referred to. A chromate, then, cannot be used in small proportion along with hydrochloric acid to prevent said acid from attacking iron equipment within a well, hence a chromate cannot be used as an inhibiting agent in the manner described in the present application. The reference does not describe treating a well with hydrochloric acid containing a corrosion inhibitor nor does it show there to be any advantage in treating a well with such mixture. The reference, then, does not anticipate the present invention."

Now, that response continues, refers to the Bureau of

Mines and also to the Lake et al. patent, and as to that I think I should read that portion of the argument that was intended to show that the Lake et al. reference had no bearing on this invention.

"Lake et al. describe removing colloidal muds, clays, etc., from the walls of a well hole or from apparatus within said hole by introducing into the well that amount of a strong mineral acid which is required to destroy the colloidal properties of the muds, clays, etc. On page 1, lines 100 to 109 of his patent, Lake states: 'It is found that the acid or acids used for these purposes will not appreciably attack the metallic structures in the well hole, such as tubing and casing, collars, and the like, where mud is present in the hole, unless used to excess, inasmuch as when an approximate balance between the amount of acid and colloidal mud is maintained, the acid action will be expanded upon the mud rather than in attacking the metal.' Lake does not disclose the use of mud as an agent capable of inhibiting the action of excess acid on iron equipment within a well. To the contrary, he specifically has pointed out in the above quotation that the protective action of the mud is due to it reacting with the acid more quickly than will iron or steel, and he also has particularly pointed out that the acid must be employed in amount which shall not exceed that with which the mud will react, i.e., there must be a balance between the mud and the acid. Present applicants have shown that a relatively small amount of any of a wide variety of inhibiting agents may be added to hydrochloric acid and that thereafter said acid may be introduced into a well to increase the flow thereof without injury to any metal apparatus which may be within the well. In employing an inhibiting agent for such purpose, the acid is in great excess over the quantity of inhibiting agent present. Insofar as is known, there is no chemical action between the corrosion inhibitor and the acid, and the acid is present in free form so that all of its activity may be expended upon the oil containing calcareous rock structure rather than upon iron apparatus present within the well.

Lake does not show that mud may be introduced into an excess of hydrochloric acid, and that the so-treated acid may be introduced into an oil well without injury to metal apparatus which may be within said well, and it is not thought that mud can be employed for such purpose. Lake does not disclose any inhibiting agent capable of preventing the action of excess hydrochloric acid upon the metal apparatus which may be present within a well treated with said acid, nor does he disclose adding any inhibiting agent to hydrochloric acid, and subsequently treating a well with the acid. Lake, then, discloses no essential feature of the present invention and does not anticipate the same."

Muehl is referred to and it is shown not to be in this invention, or even to disclose or suggest it.

Tilton is also referred to and shown not to disclose or suggest the invention.

The same applies to Coggeshall, DeGroote, two DeGroote patents, and then we come down to a specific portion of the last office action which is quoted here in my copy, it is on page ten. The quotation being:

"Furthermore, any dissolved chloride would operate as an inhibitor by suppressing the disassociation of the hydrochloric acid and such chlorides would inevitably be present."

Now, in view of the references cited, and the context, the question is whether or not the language "such chlorides" refers to anything but the chlorides that would be inevitably present in the well, and of course such chlorides which would be inevitably present in the well are those of the earth constituents or the constituents of the brines that are quite often found in wells, namely, the sodium, potassium, calcium and magnesium chlorides.

Now, after quoting this portion of the office action, the response goes on to state that there is an accompanying affidavit by one of the inventors. This affidavit shows that sodium chloride, which is a typical chloride of the kind which would inevitably be present in a well due to the fact that these things are present in the earth, and so forth, has

no inhibiting action, and the argument continued after setting up this affidavit and stating what it purports to show, namely, that even a saturated solution of sodium chloride in hydrochloric acid does not reduce its corrosiveness. The argument follows:

"Hydrochloric acid is one of the strongest of all known mineral acids and sodium chloride cannot be dissolved in aqueous hydrochloric acid in amount sufficient to suppress the ionization of the acid to such extent as to prevent it from reacting with iron or steel."

You will notice that they are discussing here the kinds of chlorides which might, if they do at all, reduce the corrosiveness of the acid by virtue of suppressing the ionization and not by virtue of putting a protective coating on the object that the acid is trying to corrode.

The argument goes on:

"The relatively small amount of brine, which may be present in an oil well, would have no appreciable action in suppressing the ionization of a hydrochloric acid solution. Neither sodium chloride nor other metal chloride may be employed successfully to inhibit the action of hydrochloric acid upon iron or steel and if they could be so employed they would, at the same time, inhibit the action of said acid upon the calcareous rock with which it is intended that it shall react."

In other words, the chlorides with which they are concerned in this discussion are merely those which might suppress the ionization, but they would not act as inhibitors in the sense in which the term "inhibitors" is used in the claims that I read first, and which were filed with the application at the time it was filed.

Mr. Lyon: Now, I want to move to strike that last sentence of the witness, that testimony, Your Honor, on the ground it is entirely improper, for the reasons I have stated in my objection, and entirely unfounded. This is a matter for the court to read this language, not for some witness to try to explain away language in the file wrapper. It is a question of law what effect this language has on this patent,

and the witness hasn't pointed to any ambiguity in the language, or attempted to aid the court by resolving any ambiguity, hasn't claimed there is any, hasn't pointed to any. The language says:

"Neither sodium chloride nor other metal chloride may be employed successfully to inhibit the action of hydrochloric acid."

The Court: I will overrule the objection.

A. Going back to that language which states that:

"Neither sodium chloride nor other metal chloride may be employed successfully to inhibit the action of hydrochloric acid upon iron or steel."

It is apparent from what I have previously read that the metal chlorides referred to are those which might, if used in sufficient amount, reduce the degree of disassociation of the acid, but they are not referring to metallic chlorides which are themselves inhibitors.

Now, I want to also point out—

The Court: This underlining, who did that, the Patent Office? A. No, that underlining was done in the response to the office action.

Mr. Lyon: That was the applicant who did the underlining, Your Honor. Are you going to read the next sentence in connection with the one you have just read? A. Yes. After the underlining, that is, as I have it in my copy, which ends with the words "shall react," a new sentence begins as follows: "Metallic chlorides, then, cannot be employed in place of the inhibitors disclosed in the application, hence the fact that such chlorides are sometimes present within a well does not invalidate patentability of any claim in the application."

Now, when we turn to the application, we see what metallic chlorides this is all about, we see immediately that arsenic is one of the metallic chlorides which is disclosed in the application, and now in the issued patent, which is an inhibitor as distinct from these chlorides talked about here, which are inevitably present in the well, and that might act to suppress disassociation of the acid, but do not act as metallic inhibitors.

The Court: Isn't there a little arsenic in the brine in the well? There is in the ocean. A. There may be a trace of a trace of a trace, but no inhibiting quantities are present. Arsenic is certainly not to be encountered in any significant amount in a well.

The Court: Do you say that it is obvious from the specification that Grebe and Sanford said to add arsenic chloride to the bath as an inhibitor? A. I used the words "arsenic chloride," yes, and that was because in this disclosure of Grebe and Sanford, which is the same as in the issued patent, he tells to use arsenic in hydrochloric acid, the arsenic being added as either the trioxide, or as an arsenate, and that there will be an arsenic chloride solution in the acid, and that is, of course, a metallic chloride, and obviously that—

Mr. Lyon (interrupting): The patent does not say that. The specification does not say that.

A. Anybody knows that when you put those things in hydrochloric acid, it becomes arsenic chloride.

Mr. Lyon: I don't know it, so don't include everybody.

A. The Beneker patent has that, and there were many others that showed that same thing.

Mr. Lyon: Instead of arguing with me, will you just answer my question. The specification does not state that the arsenic compound that is employed forms arsenic chloride, does it? A. I do not know that the words appear there.

Mr. Lyon: Is it your understanding that arsenic acid which is specified will form arsenic chloride in hydrochloric acid? A. Yes.

Mr. Lyon: Arsenic acid? A. Yes.

Mr. Lyon: Will it form pentachloride? A. Yes.

Mr. Lyon: Is there such a thing? A. In a hydrochloric solution, yes.

Mr. Lyon: Is there pentachloride? A. Yes.

Mr. Lyon: Are you sure about that? A. You can refer to the handbooks to see, I should say.

Mr. Lyon: Suppose you refer and see if there is such

a thing as arsenic pentachloride. A. It forms a chloride, it says, perhaps it is not penta—it is most likely an arsenic trioxide—

Mr. Lyon (interrupting): When you said a moment ago that all you had to do was to refer to the application and you would find a disclosure of the use of arsenic chloride, why, you meant that you would find that arsenic compounds were added, and that, you say, forms chlorides, but the patent specification does not say so. Is that what you mean to say now? A. The chemical books are that if you proceed, as taught here, you will form a metallic chloride solution, the chloride being arsenic.

Mr. Lyon: Did the Examiner know that? The application did not tell him? A. He undoubtedly would know that.

Mr. Lyon: How do you know that? A. Because everybody knows it.

Mr. Lyon: I didn't know it. A. You probably don't know the chemical books then.

Mr. Lyon: I don't know whether the court knows it or not, or whether he knew it before he went into this case. A. The Beneker patent disclosed that information.

Mr. Lyon: I want Your Honor to get the right conception of this, and that is, if this witness is going to read this file wrapper and make an argument, he ought to be accurate. He says that the application discloses adding an arsenic compound which he says will form chloride, but the application does not disclose that it will form chloride. A. That doesn't prevent them from forming. It is a fact of nature.

Mr. Lyon: Now, were you going to read this next sentence, or have you? A. I have read that two or three times now.

Mr. Owen: I would like to continue with my examination.

Mr. Lyon: All right.

Mr. Owen: I did not object to your questioning, because I thought the court would be interested in having the point cleared.

Mr. Owen: I will ask you if there is any difference in the manner in which arsenic acid placed in hydrochloric acid will act as an inhibitor against corrosion of iron than there would be if arsenic trioxide were placed in the hydrochloric acid? A. No. The first action would be the conversion of the arsenic by the acid into arsenic ion and chloride ion and the inhibiting action would then be identically that of the arsenic chloride.

Q. And the inhibiting action cannot take place until the arsenic ion and chloride ion are formed; is that right? A. That is right.

Q. And at the time that affidavit was filed were there claims existing in the application which specifically claimed the introduction of arsenic compound as the inhibiting agent? A. Yes.

Mr. Lyon: I would like to have my objection stand to all of this testimony, without repeating it, Your Honor.

The Court: It does.

Mr. Owen: Will you point out one or more of those claims? A. Claim 2, as originally filed, read as follows:

"In a method of increasing the output of a well for producing a fluid mineral product such as oil, gas, water or brine, the step which consists in introducing into the well an aqueous hydrochloric acid solution to which had been added a relatively small amount of an arsenic compound."

Q. Now, would arsenic acid be an arsenic compound? A. Yes, it would.

Q. And would arsenic trioxide be an arsenic compound? A. Yes, it would.

Mr. Owen: Does the Grebe and Sanford patent disclose more than one form of arsenic compound? A. Yes.

Q. What forms does it disclose? A. Page 1, column 2, in the last paragraph, beginning at about line 78, the statement is:

(Reading): "As the inhibiting agent we prefer to use an arsenic compound soluble in the acid solution, examples of which are arsenic acid, H_3AsO_4, arsenic trioxide, As_2O_3, or a soluble arsenate or arsenite, such as the corresponding alkali metal salts."

The Court: Corresponding to what? A. That means corresponding to arsenate and to arsenite. Arsenic forms two series of salts; the compounds which are trivalent correspond to arsenites, and the compounds in which arsenic is pentavalent correspond to arsenates.

Q. Will you write on the blackboard the equations which represent the reactions of these different arsenic compounds when placed in hydrochloric acid? A. I will take a typical example, which will be arsenic trioxide, as that is the common commercial compound of arsenic; As_2O_3 is the formula of arsenic trioxide. HCl is the formula for hydrochloric acid. When these two materials are brought together, the trioxide is converted into arsenic trichloride, and water is formed, H_2O.

The Court: I don't think you have enough parts on the left of the board there. You have got to put some figures in front of them. A. That is right. The next step here will be to balance up this equation so that the quantities on this side add up to the quantities on that side (indicating). There we have a little more water here.

The Court: Yes. A. Now, then, we have three oxygens here and three there. Six hydrogens there; six here. Six chlorines, and twice three is six chlorines. Two arsenic and two arsenic. So that it balances up. That is the same reaction that is given in the Beneker patent No. 914,916 issued March, 1909, to which reference has already been made in the previous part of the testimony.

CROSS EXAMINATION

By Mr. Lyon:

In your opinion, would it have been obvious to a man skilled in the art, from the knowledge of electroplating solutions, that corrosive acids such as hydrochloric acid and dilute sulphuric acid could be safely transported and stored in steel containers? A. I don't know whether it would have been obvious or not.

Q. Well, what is your opinion? A. It doesn't—from

what I have seen in the literature, it is apparent it would not have been safe.

Q. It would not have been safe to have shipped hydrochloric acid or dilute sulphuric acid in steel containers? A. That is correct.

Q. Would it have been apparent from this knowledge that you referred to, this prior knowledge in electro plating solutions, that hydrochloric acid could be transported from storage stations to oil wells in steel transportation tanks if you had added to such hydrochloric acid the same solutions? A. It is obvious there would be less corrosion.

Q. I am not asking you that. A. What are you asking me?

(Whereupon the question was read by the reporter.)

A. I don't know what you mean by the question.

Q. I will attempt to restate it. You have in mind this prior art prior to Gravell that you have referred to which disclosed different solutions or different formulas employed in electro plating operations, have you not? A. I have referred to some such, yes.

Q. And you have those in mind? A. I have some of them in mind.

Q. Those solutions or formulas which you have referred to are the ones I am going to inquire about in this testimony. Now, in your opinion, would it have been obvious to a skilled man from knowledge of those electro plating solutions that he could have transported hydrochloric acid from storage stations to oil wells in steel tanks or containers without serious injury to the containers if he had added such solutions to his acid? A. It would have been obvious that there would have been less corrosion if he had used those compositions.

Q. Well, would it have been obvious to him there would have been sufficiently less corrosion to enable him to transport the acid in that manner that I have described? A. No, I think not. It would be obvious that if you had attempted it, although the corrosion would have been reduced in some cases depending on what solutions were used there still would be a hazard, a great hazard.

Q. Then, as a matter of fact, no one prior to Gravell actually disclosed, in your opinion, enough information to necessarily teach one that corrosive acid could be transported or stored in steel containers without substantial injury to the container. A. The art that I have come across disclosed exactly as much as the Gravell patent.

Q. I didn't ask you that. A. That is what it sounds like to me.

Mr. Lyon: Will you read the question to the witness, please? A. The reference disclosed the same information that the Gravell patent disclosed, Gravell mis-stated what the result was.

Mr. Lyon: I move to strike out the answer.

The Court: What he is asking you doesn't involve the Gravell patent at all.

Mr. Lyon: Excepting fixing the time. A. Then I don't understand what he wants to know.

Mr. Lyon: Then read the question to the witness.

(The question was read.)

A. Disclosed the same information as Gravell disclosed.

The Court: Now, then, I will leave "Gravell" out and ask the question, you misunderstand it; did anyone, prior to July 31, 1928,—now put your question without involving Gravell at all.

(Mr. Lyon): —sufficiently disclose so that it could be known by one skilled in the art that a corrosive acid such as hydrochloric acid could be stored or shipped in a steel container if you added thereto any type of an inhibitor? A. That depends on what you mean by "storage" and what you are talking about; you haven't told me; I can't answer that any more than I have already answered.

Q. Well, let's ask you to answer that question with reference to transporting the acid from a storage station out to a well, in a steel transportation tank. A. You will have to be more definite; that is still indefinite.

Q. What is indefinite about it; don't you understand that? A. No, I don't. You will have to make it specific.

Q. Is it you don't want to answer these questions? A. Oh, no, I am willing to answer them, but I cannot answer this indefinite question.

Q. You are not trying to dodge these questions? A. Oh, no, I will answer as far as I know the answer.

Q. Let's take the distance from Mount Pleasant out to one of these wells, these four wells, let's take the Crawford well that your side has produced evidence, samples taken from that well; how far is that? A. I don't know.

Q. You don't know how far any of these wells were? A. No, I don't.

Q. Well, let's say they were 75 miles? A. Well, I don't see what distance has to do with the problem; maybe it has.

Q. All right. What is the thing you don't understand about the question, if it isn't the distance? A. The whole question, if you can pin it down to some specific material and conditions under which it is to be used, and so forth, it might be possible to give you an answer.

Q. Well, what fact of the question do you need to know; you tell me. A. Well, you will have to repeat the question now, I have forgotten the details of it.

(The question was read.)

A. Well, I would like you to specify the concentration of the acid, the conditions of temperature; the kind of container; the conditions under which the container is to be manipulated; and the time this is to go over, and so forth.

Q. You would have to know all of those things to be able to answer that question? A. I believe so.

Q. You cannot answer it without all of those details? A. Because time is a factor—

Q. I am not asking you to argue it. I am asking you to answer my question. Is it your statement that you cannot answer that question without all of those details? A. I cannot give you a definite answer yes or no, if that is what you mean.

Q. I didn't ask you for a definite answer yes or no. A. I thought you asked whether it could be done, in the

light of this knowledge that is in the prior art. Isn't that a yes or no question?

Q. Haven't you an opinion as to whether it would have been obvious to one skilled in the art to do that, or not? A. I think with some compositions it would have been, yes.

Q. What compositions? A. Those that appear in the—some of the compositions that appear in the Watts article, where the rate of corrosion of any of the acid solutions containing some metals is relatively low.

Q. Let us talk about hydrochloric acid. A. Well, as to that acid, I presume that it would be partly obvious and partly not obvious depending upon the time factor.

Q. Well, how long? A. If we had to do this in a relatively short time, one could get away with it with a relatively small reduction of corrosiveness of the acid, but if one had to allow the acid to remain in contact with the container for a relatively long time, then I don't think it would be obvious to do any of these things.

Q. Well, what I am getting at is this: I am talking about the use of a tank, steel tank for transporting 15 per cent hydrochloric acid from service stations out to oil wells. If I am going to use the tank, I am going to use it repeatedly and one day it will be—a truck will go to a well that is further out than another one, and you know, you are in this business, you know those conditions. And I want to know whether it would, from this prior art that you have presented here, showing these solutions that were employed in the electroplating, in your opinion it would have been obvious to anyone skilled in the art, that he could have transported his 15 per cent hydrochloric acid in the regular conduct of his business from his storage station out to his oil well safely, using those solutions or adding them to the acid? A. Oh, I don't believe I would know whether that was obvious or not.

Q. You wouldn't know whether it was or not. Have you any opinion? A. Well, I could express an opinion there, I think.

Q. What is your opinion? A. I think it would be obvious that those solutions would be less corrosive than the acids of which they were composed, in many cases, and if conditions were such as to permit it, it would be obvious that they could be carried around in iron or steel.

Q. It would be obvious, then, from that, that the metal in contact with the acid would not be injured by the acid, isn't that correct? A. Oh, no. The references do not disclose that. The references disclose that the corrosiveness of the acid within which these metallic inhibitors are used, is greatly reduced. In no case do we reach the stage of what one might call prohibition, that is, where no corrosion occurs at all. That object is never attained by any of these prior art references.

Q. Let's put it this way: Are you familiar with the extent to which the tank, steel tanks, employed by the Dow Company, corrode in actual use? A. No, I am not.

Q. In the presence of inhibitors? A. No, I am not familiar with that.

Q. You haven't any information? A. I have never seen the inside of a Dowell transportation tank.

Q. You haven't any knowledge of how much corrosion they do prevent? A. No, I haven't.

Q. Have you any opinion about how much they can prevent? A. Well, I could make a guess, but it wouldn't mean anything.

Q. Well, do you think that anyone would know from—any skilled man would know from this prior art that you have read here, described in the solutions used in electroplating operations, that by the use of such solutions he could transport 15 per cent hydrochloric acid in steel transportation tanks from storage tanks out to oil wells, and not get any more injury than the Dowell Company gets? A. Well, you are asking me for something as to which I don't know. You are asking me how much injury the Dowell Company trucks have, and you want me to use that as a standard of comparison, and I just said I don't know how much injury they suffer in this business.

Q. Do you think that these prior patents and publications describing these solutions or formulas used in electro-plating operations would necessarily disclose to a skilled man in the art that by using them he could transport or store 15 per cent hydrochloric acid in steel containers at all, without substantial injury to the containers? A. As I said before, it depends on the degree of this thing you are talking about, its composition.

Q. I said, "at all" first. I said "at all." A. None of them, as I have said, are so little corrosive that they do not do some corroding, as compared to, say, something like water. As I said before, those solutions that are in the electro-plating art there, show that they are relatively less corrosive than the acids themselves, and to that extent, of course, it suggests that they could be brought into contact with iron or steel without doing as much damage to it as the plain acids would; but the articles themselves, except for a few that I mentioned, do not suggest carrying such acids about in iron or steel.

Q. Is there any disclosure in the prior art that you have referred to in your opinion which would establish to any skilled man in the art, that the solutions or formulas mentioned in the prior art could be used with 15 per cent hydrochloric acid, to reduce the rate of corrosion to a point where you could probably store or ship such acid in steel containers, without serious injury to the containers? A. Well, that is a problematical question, of course.

Q. But I am asking you for your opinion? A. Yes.

Q. You studied this prior art? A. Yes, but as I said before, these compositions are a great deal less corrosive in some instances than the plain acid itself; and one reference which I do not think has been referred to on my direct testimony, discloses that in about a 19 per cent solution of hydrochloric acid, certain of these Gravell metals reduce its corrosiveness; but I don't think—I do not have a reference which answers your question, which is directed to the 15 per cent hydrochloric acid. I cannot give you that because I do not have a reference which discloses that specific proportion.

Q. Have you a reference on the same question for any corrosive acid of the— A. Yes—sulphuric acid, for example?

Q. Which reference? A. The Watts article, an article by Watts in the American Electro-Chemical Society, 1909,—that discloses many Gravell metals, some of which when put into acid greatly reduce corrosiveness, and others of the Gravell metals which accelerate this corrosiveness.

Q. Now, does the article teach in regard to arsenic, Watts' article? A. That article shows that the addition of arsenic greatly reduces the corrosiveness of that acid.

Q. Wouldn't it be obvious from that article that you could safely transport or ship corrosive sulphuric acid in steel containers without serious damage to the containers, if you added arsenic? A. It would be obvious as to about what extent damage would occur if the acids were so transported or shipped.

Q. What do you mean by that last answer? A. That the rate at which acid attacks steel or iron is given in research work of Watts, and from that an estimate of damage to a steel container could be made.

Q. Do you agree that all that any inhibitor that anybody knows of, or has suggested, can do, so far as the corrosive rate of a corrosive acid is concerned, on steel, is reduce it more or less, but cannot completely eliminate it? A. I haven't found a reference showing an inhibitor which goes so far as to prohibit corrosion by the acid on your steel.

Q. When you say "a reference," you haven't found any such inhibitor anywhere that you know of? A. That is right.

Q. Now, you mentioned what this article by Watts— A. That is, in printed matter; I am not saying I don't know of some to exist, but—

Q. Well, you know what arsenic will not do? A. In printed publications and things that are available to the public.

Q. Well, arsenic will only somewhat reduce the rate

of corrosion, it will not completely stop it? A. Arsenic will not completely stop it, but it comes right close to it with certain concentrations of sulphuric acid, but it does not actually stop it, of course, because in order to work arsenic has to plate out and in order to plate out iron has to dissolve, and if iron dissolves, it is dissolving, it is not remaining inert or unattacked.

Q. Is your last testimony equally applicable to the effect of arsenic in 15 per cent hydrochloric acid? A. I don't know what you mean by my last testimony.

Q. I mean your explanation of what arsenic will do in corrosive sulphuric acid; is that also true of arsenic in 15 per cent hydrochloric acid? A. Not in the same—not to the same extent. I believe from what I have found in these references the effectiveness of arsenic in reducing the corrosiveness of hydrochloric acid is quite a lot different than its effectiveness for reducing the corrosiveness of sulphuric acid, giving due regard to the concentrations.

Q. Tell us about it. A. The effect of arsenic varies with the concentration of the acid in which it is placed.

Q. Well, I have given you 15%. A. Yes. Well, as I stated, with that specific concentration I do not have a reference that gives us very much help. The nearest we can come to it is the Watts article that has about a 19% solution, as I recall it. I am not absolutely positive in that solution he placed arsenic.

Q. You don't know anything about these various matters I have been asking you about except what you can read in the prior art brought in, these patents you referred to. You don't have any independent knowledge of your own? A. Oh, yes, I have knowledge.

Q. Why do you limit your answers to the references you can find? Why don't you tell me what you know? A. I will be glad to if I understand the question.

Q. Now, you have referred to this article by Watts. Will you turn to page 338. This is the transcription American Electro Chemical Society, Volume 21, for the year 1912. A. Yes, I have that now. What page is it?

Q. Page 338. I am reading from a paragraph commencing in the middle of page 338. "It appears, then, that arsenic is unique among the metals which precipitate themselves upon iron from solution, for arsenic protects iron almost completely from powerful corrosive agents, while the other metals are generally considered to aggravate corrosion and rusting." Now, wouldn't anybody skilled in the art know from that that if you are interested in protecting an iron pipe or an iron tank in which you had a corrosive acid in contact with the metal that you could use acid, arsenic, and that arsenic would protect the iron "almost completely"? A. Well, you have to consider the findings on which that is based. Of course that is a general statement and doesn't apply to all acids, although the way it is stated here it seems to. If one looks at Watts' data on which that is based, you certainly couldn't reach any such general conclusion with respect to arsenic, I don't believe. However, it is different from the other metals in that respect; it does more than the other metals do.

Q. It is much more powerful as an inhibitor or corrosion reducer? A. Oh, yes, it seems to be in quite a different class than any of the other Gravell metals, with the exception of copper.

Q. Well, now, will you turn over to page 341, which is Mr. Watt's table, where he gives the results of his tests, and comparing the amount of corrosion in 24 hours with arsenic with the blank and comparing the amount in 48½ hours with arsenic in the blank, in per cent, how much corrosion was there with the arsenic as compared with the blank. A. It should be pointed out, of course, that this data is based upon experiments done with sulfuric acid and not with hydrochloric and that the concentration of—

Q. (Mr. Lyon interrupting): I didn't ask you anything about that. I asked you to compare. A. I can't give you the corrosion figure without reference to what it is about.

Q. Why not? A. It wouldn't have any meaning.

Q. I am not asking you to give the meaning. I am

asking you to give the calculation. A. What kind of a calculation do you want me to give?

Q. The blank in 24 hours shows 6.64 grams of corrosion, while with the arsenic it showed 0.07, did it not in that length of time? A. Yes, it did.

Q. And in 48½ hours the blank showed 10.32 grams, and with the arsenic it showed 0.10 grams, isn't that correct? A. That is correct.

Q. That is less than 1%, isn't it? A. The difference in weight losses is in the order of 1%, less than 1% slightly. In other words, in terms of our inhibition calculation that would be a sulfuric acid solution which was about 99% inhibited.

Q. You do not want to tell us whether in your opinion this prior art that you have referred to, take it altogether, would reveal to one skilled in the art, the fact that by the use of the solutions or the inhibitors there disclosed, he could transport or store a corrosive acid, such as 15 per cent hydrochloric acid, in a steel container? A. On the contrary, this Fawsett article does disclose and teach that very idea. He gives some quantitative figures as to the rate at which the container might be attacked.

Q. Well, then, from that article you would not need anything more to know that if you were going to transport 15 per cent hydrochloric acid in a steel tank, or through a steel pipe, but what you could protect that pipe or that tank from the corrosive action of the acid by using the inhibitors referred to. Do you agree with that? A. As I said before, the reduction in corrosiveness that can be had is indicated in some of these articles, for example, the concentrations, that I do not happen to find the 15 per cent hydrochloric acid. This Watts article on page 344 gives it for a 19 per cent, if you add arsenic to it, and we get about the same reduction in corrosiveness in 19 per cent hydrochloric as we get with sulfuric acid with arsenic, using about the same amount, I believe.

Q. Well, then, you would know from that that you could— A. So you can put those two together, at least.

Q. You would know from that, if you were a skilled man in the art, that you could use arsenic and protect a steel transportation tank or pipe from corrosion of 19 per cent hydrochloric acid? A. To this extent.

Q. Does that article indicate that the extent is enough to reduce the rate of corrosion to a rather small figure? A. Yes, but it does not state whether that is the same figure.

Q. Well, then, it is a question of somebody finding out whether you can safely use a tank or a steel container or a pipe for acid if the rate of corrosion is reduced to one per cent by arsenic. Is that the thing that was left for somebody to find out? A. I do not know if that was the thing that was left for somebody to find out, but that would certainly be something one ought to find out before trying this thing.

Q. All right. Let us put it in this way, it is now your opinion, is it not, that any skilled man from this prior art which you have produced, would know that if he was using a 19 per cent hydrochloric acid, he could protect a steel container or a pipe, from corrosion by that acid up to one per cent of the amount of corrosion which it would have if he did not use any arsenic? A. I think that would be correct.

Q. Now, you don't have any reference for whether or not 1 per cent is more corrosion than you can safely allow if you are shipping or storing in steel containers or pipes. Is that all you lack? A. Well, that is difficult to answer offhand. I presume it would be possible to compute from Watts' data and get the figure for comparing with the Fawsett data, and from that you could show that even though you had put in arsenic and thereby greatly reduced the corrosiveness of the acid solution, that same solution in a steel drum would, of course, eventually explode it, due to the fact it would generate hydrogen and burst the drum. Now, how fast it would be, would be a matter of time.

Q. How soon would that take, how long would that take? A. I can't make the calculation offhand. It would

take some time. All these things take some time. They don't occur instantaneously. The prime factor is indicated in part by this corrosion rate figure, although it is not an absolute measure of this thing.

Q. Can you give us some idea, if you cut it down, cut the corrosion rate down where it is—the remaining amount of corrosion is only 1 per cent, how long would it take to explode an air-tight container? A. Well, 1 per cent of what?

Q. Well, take dilute sulfuric acid and give us the figure for that, if you can? A. Oh, I should imagine a few hours.

Q. How about 15 per cent hydrochloric acid? A. Oh, it would be a few hours. It would not take very long before the drum would explode.

Q. Even with arsenic? A. That is right.

Q. And when you ship these—do you know whether or not these transportation tanks are air tight or not? A. I don't know. I don't think they are.

Q. Well, is it necessary that if you are going to store or ship hydrochloric acid or corrosive sulfuric acid, that the container be air-tight? A. It is in some instances, I believe. Not in all.

Q. Well, in what instances is it necessary? A. I don't know.

Q. Well, this prior—this danger of explosion would be avoided if you had a tank vented, would it not? A. Well, only partly, because the contents of acid could come out, too, and it would not be very satisfactory.

Q. If you are going along in an automobile truck you could have a vented tank with no real danger or no actual danger of anything spilling out of it? A. I think so.

Q. Why, certainly. You haven't told me so that I am sure that I have an unequivocal answer from you, whether or not you think, in your opinion, this prior art actually discloses the use of inhibitors to such an extent that it would be apparent to a skilled man in the art, who wanted to know whether—wanted to know how to protect steel from

hydrochloric acid, that he could do it by using the solutions and materials disclosed in these prior references? Can't you give us an unequivocal, clear-cut answer? A. Yes. The answer to that is that it is so with certain things, not with all things either, but with certain of the things.

Q. Let's talk about hydrochloric acid. Would he know that if he wanted to protect steel from hydrochloric acid, that the thing to do would be to get such inhibitors as you have pointed out or disclosed in this prior art? A. For certain purposes. You have got to limit the thing.

Q. I am talking about the purpose of protecting the steel? A. Yes, but what do you mean by protecting?

Q. That is in contact with the acid. A. I don't know what you mean by protecting the steel.

Q. I mean protecting it against severe corrosion. A. Well, what do you mean by that?

Q. From the acid. A. I don't know what you mean by that. That is just relative language. It has no significance.

Q. It doesn't have? This word "inhibitor" doesn't have any significance? A. I didn't say that; all of these things which are classed as inhibitors reduce the corrosiveness of the acid on iron or steel.

Q. But that has no significance unless you know how much? A. Well, it depends on whether you are interested in the quantitative result or not; you are asking me for a quantitative result.

Q. Is the Grebe and Sanford patent interested in a quantitative result? A. No, you are interested—

Q. I am asking, is it interested in a quantitative result in any way? A. In this case it is interested in reducing the corrosiveness of the acid so that it will not damage the equipment as much as if it were not inhibited.

Q. Supposing the skilled man I am talking about was interested in reducing the corrosion that would be caused by hydrochloric acid in contact with steel, would he have known, would it have been apparent from this prior art that you have produced here today that he could have ac-

complished that by using the inhibiting materials and the solutions that are disclosed in that prior art? A. Absolutely. The art is full of inhibitors, not just this that I have gone through, but there is much more; I have just touched on a fraction of it.

Q. And he would know that was true so far as reducing the corrosion on steel contacted by the acid, no matter what that form of that steel was, I mean whether it was an article or a container, the only significant thing would be that there would be a steel surface in contact with the acid? A. No, I don't think you would go that far, although qualitatively that would be all right, but we do have some troubles that are due to the container surface itself, where there might be some inhomogeneity in the structure of the container.

Q. Well, a man would know that inhibitors that would reduce the corrosiveness of hydrochloric acid to steel would operate whether the steel that the acid contacted was in the form of a tank or in the form of a pipe, wouldn't he? A. Oh, yes, yes, bearing in mind, however, that there are some differences due to structure, but qualitatively they would be about the same as I have said, a pipe and a tank would be put in the same class, except for the possibility of the tank, a structure having different metallic compositions. A pipe is liable to be more uniform.

Q. Now, do you think there is anything wrong with Mr. Gravell's listing these different things as acid regulators or pickle control substances from the prior art? I mean did he get anything in here that the prior art didn't justify him in stating were known in the prior art as pickle control substances or regulators? A. I don't think there would be anything not to justify them other than the indefiniteness with which they are set forth.

Q. Let's compare the Grebe and Sanford patent in that respect. Turn over, please, to the Grebe-Sanford patent, bottom of the first page, second column—"Other inhibitors which may be used are cyanides, organic nitrogen bases such as aniline, phenyl-hydrazine, pyridine, quin-

oline, acridine and derivatives thereof, organic sulphur compounds, such as mercaptans, as well as various by-products of industrial processes, such as sludge acid from oil refining and residues from acid sulphite paper manufacture, etc." Now, let's compare this list, this third column that you have in your exhibit, made under the Gravell patent, and tell us how many different corresponding classifications are in this Grebe-Sanford patent at this point. A. These fit very well with that. Starting with the cyanides in Grebe and Sanford, that corresponds to 12 on the chart.

Q. Well, now, there is just as many cyanides included under that class in the Grebe and Sanford patent as there is under the Gravell patent, isn't there? A. I think it would be so. However, one must recall the fact here that what Grebe states is that you would choose inhibitors. I don't know whether all cyanides are inhibitors, but you are to choose them from such class as you wish.

Q. Of course, Gravell chooses from—he chooses from such of those materials as are known to be acid regulators or pickle control substances, doesn't he? A. I think that is correct, yes.

Q. Surely. Well, then, he is asking you to choose the same thing Grebe and Sanford is asking you to choose, isn't he? A. Well, that is the point of which I am not certain, because Gravell nowhere states what he means by an acid regulator.

Q. But the prior art taught that they were inhibitors, didn't it? A. The word "acid regulator" does not appear in the prior art, to my knowledge.

Q. "Pickle control substances" does? A. That does not, either.

Q. The word "pickle control" doesn't appear? A. I couldn't find it.

Q. I thought you read from things— A. We read "controlling."

Q. "Pickling solution." A. "Pickling solution" occurs, but we did not find those terms. You can read into them this matter, if you wish.

The Court: Aren't they necessarily inhibitors? A. No.

The Court: What? A. No.

The Court: Picklers. A. We can tell by looking at these they weren't. For instance, sodium bisulfate is not an inhibitor. It is a corrosive substance, very corrosive.

(Mr. Lyon): Well, let's take along here now. (Indicating on chart.) First thing are the cyanides. Just plain cyanides. You say there is 91 inorganic and 87 organic cyanides, on the chart for the Gravell patent? A. Yes.

Q. Is there anything there you omit, anything to select from those indicated in this Grebe and Sanford patent? A. The Grebe and Sanford patent indicates that they are to be inhibitors. But this doesn't.

Q. How do you know? Are all these 91 inorganic and all these 87 organic cyanides inhibitors? A. I don't know.

Q. Do you know whether there are any of them that aren't? A. I couldn't say that, either.

Q. Well, if there are some that are and some that aren't, the Grebe-Sanford patent don't tell you how to find one from the other, does it? A. No, it doesn't.

Q. Any more than Gravell tells you how to find which ones are acid regulators? A. That is right.

Q. Now, let's skip over to the next class, organic sulfur compounds. A. I misspoke myself, please. I don't want to say that this Gravell indicates that you should choose such of these cyanides as are inhibitors. There is no speaking of an "inhibitor" anywhere in the Gravell patent. That word is never used, and it don't appear in any part of the specification.

Q. But you do think he started to pick out those that have been used in pickle control as pickling compounds? A. I would think that was the import of that paragraph.

Q. And many of those, from your references this morning, actually act as inhibitors? A. Some of them do, but many of them don't. You have both kinds of things there. That is the reason there is a difference.

Q. Well, now, let's take this next class on page 2 of

the Grebe-Sanford patent, it says organic sulfur compounds. Where would they go on here? A. There aren't any on that Gravell chart, to my knowledge.

Q. How many organic sulfur compounds exist, theoretically, or possibly? A. Well, I don't know that. But, as a guess, there would be a great many.

Q. It would be up in the hundreds of thousands? A. Oh, I don't think so.

Q. How many? A. I don't know.

Q. Do you know whether they are all inhibitors or not? A. Undoubtedly not.

Q. Do you know which ones are inhibitors? A. The common ones that are known to be inhibitors are ethyl mercaptan, and the lower mercaptans. Many of the mercaptans are common ones.

Q. Any others? A. I think the thio-urea would be another one.

Q. When Grebe and Sanford here use the phrase "organic sulfur compounds such as mercaptans," do you think that that should fairly be construed as a statement that they were including all organic sulfur compounds? A. No, I wouldn't say that. What it conveys to me is that you can find in those classes such things as may be used as inhibitors and which were known in the art as of that time as inhibiting agents, and there are quite a few disclosed.

Q. You should read the Gravell patent in the same sense. A. I am, but with this distinction, that Gravell doesn't state that these things that are called acid regulators should have inhibiting action.

Q. He doesn't use the word "inhibiting"? A. Well, even more than that, he has listed in his group things that are not inhibitors, therefore I take it that he didn't intend to limit himself either in his disclosure to such things as would have an inhibiting action.

Q. Now, you condemn the Gravell patent for referring to sludge acid from oil refining, or what corresponds to that, in this column three of the Gravell patent. A. I don't think I condemned it.

Q. That is number 29, isn't it? A. This talks about the waste acids from refining hydrocarbons, that is not the same thing. Sludge acid is a very particular type of product.

Q. Is it or isn't it? A. It is my understanding it is.

Q. Where do you get it? A. I couldn't go into that.

Q. Your understanding is not very definite about what it is? A. That is true, aside—

Q. Do you know whether the acid sludge from refining a mineral oil differs from that from refining a gasoline? A. I don't know.

Q. Do you know whether it differs from the one you get from refining a lubricating oil? A. I don't know.

Q. Do you know whether all of them together differ from the same parallel sludges, if they are made with a different chemical? A. I don't know, but, as I say, I was under the impression that this sludge acid, was a relatively different thing, that you go to the refinery and you get that stuff.

Q. What do you think you would get if you went to an oil refinery and said, "I want some sludge acid." A. I don't know what you would get.

Q. Then as far as you are concerned, and your testimony is concerned, you would have to say the words "meaning indefinite," under item 29, on your third column, would apply— A. No, it is not the same language; item 29 says, "Waste acids from refining hydrocarbons."

Q. The meaning of sludge acid in the Grebe-Sanford patent is indefinite to you, isn't it? A. No, it is not indefinite to me, because I don't know what it is.

Q. How about "residues from acid sulfite paper manufacture"; do you find anything that corresponds to that on this? A. Yes.

Q. What is it? A. Number 10 may be, "cellulose pulp waste," it happens to be one place I suppose you might go to for that; I don't know what it is; and then there is something else further down, "sulfite lye," I think that is another term for the same sort of thing. How they distinguish from each other, I don't know.

Q. Do you know what this one is, what this material is and how definite a material it is that is referred to by Grebe and Sanford? A. No, I don't.

Q. Under the words "residues from acid sulfite paper manufacture"? A. I don't know, no.

Q. But you have testified now that a fair rating of a phrase like the phrase, "organic sulfur compounds, such as mercaptans" in the Grebe and Sanford patent, shouldn't be taken as implying that all organic compounds are included? A. That is right.

Q. Now, I want you to turn over to the Gravell patent and look at the last paragraph in the first column of the first page, line 41. "The metals which have that property are below iron and above mercury in the electro-motive scale. Under certain conditions tin produces good commercial results. However, arsenic in most cases is more satisfactory." It is true, isn't it, that tin is below iron and above mercury in the electro-motive scale? A. Yes.

Q. Copper chloride, lead chloride and iron chloride are all metallic chlorides, are they not? A. Yes.

REDIRECT EXAMINATION

By Mr. Owen:

Q. On page 338 of the Watts article, to which you have referred, I believe there is a statement to the effect that arsenic protects iron almost completely. I wish you would quote that correctly. A. On page 338 of Watts, in Volume 21 of the American Electro-Chemical Society transactions, I read as follows:

(Reading): "It appears then, that arsenic is unique among the metals which precipitate themselves upon iron from solution, for arsenic protects iron almost completely from powerful corrosive agents, while the other metals are generally considered to aggravate corrosion and rusting."

Q. Now, assuming that that statement by Watts is true, regarding the protective properties of arsenic, what would you say as to its being obvious to one who read that

statement that if one of these highly corrosive acids which he speaks of were placed in a steel drum, the presence of arsenic would have the effect of protecting the drum from corrosion? A. Well, if this statement were true, one could assume from this that arsenic would protect the drum from a corrosive attack by an acid.

Q. Supposing one desired to store one of those acids in a steel drum, and to protect the drum by the presence of arsenic, how would he proceed, or how could he proceed to ascertain how long that protection would last? In other words, how long the container would hold the acid from being eaten through, or being blown up, if the container were closed? A. He would prepare a solution of the acid, and add to it arsenic in a manner, of course, to get the arsenic dissolved in the acid, and put that solution in the tank, or, the container, and set the container aside, and watch what happened as time went on. If he would desire to test it either open or closed, he would naturally proceed to set some drums aside with the solution in that were sealed, and others that were not.

Q. If in that way he learned of the length of time which he could safely rely upon for the continuance of the protection obtained by the presence of the arsenic, what would he then have to consider in order to determine whether or not a drum so protected could be used commercially for a certain purpose? A. One would have to consider the interstate regulations, as to whether or not one could proceed with this thing without violating the Interstate Commerce regulations as to the shipment of such acid.

Mr. Lyon: If the court please, there are still some things that can be done in this country without crossing the state line. You still can do some business in this country without doing it in interstate commerce.

Q. (Mr. Owen): What else would this party have to consider in determining whether or not he could use this form of protection for the proposed purpose? A. A vitally important feature would be to determine whether or not the presence of this constituent would interfere with

the subsequent use of the solution after the storage and transportation of it was done.

Q. And if he found that the presence of the arsenic would give him sufficient protection to get by the interstate commerce regulations, and that it would not contaminate the hydrochloric acid so as to make it improper for its intended purpose, then I assume all he would have to do in deciding whether or not he would store or ship his acid so treated, would be to determine the length of the storage period or the distance and time consumed in transportation? A. That is right.

FRANCIS NELSON ALQUIST,

a witness called in rebuttal by plaintiff, testified as follows:

I have been employed by The Dow Chemical Company as a research chemist since about August, 1930.

I received my graduate degree from Clark University of Worcester, Massachusetts, then I was an instructor in chemistry at Rensselaer Polytechnic Institute, Troy, New York, Department of Chemical Engineering, Department of Chemistry at St. Lawrence University; took graduate work at the University of Chicago, and five years instructor doing graduate work at Purdue University at Lafayette, Indiana. I received my master's degree and doctor's degree from Purdue University, where I specialized in organic chemistry, minor, and inorganic chemistry, and

majored in organic and minored in chemical engineering dealing with metals.

The first few years I was with Dow I was engaged in organic research development of new compounds, new processes for the plant use, and then when Dow became interested in oil well work, I became interested in work along that line. Since that time about half my work has been spent on the chemicals in relation to oil well work, and about half in organic research.

I have been familiar with the Gravell patent No. 1,678,775 since probably November, 1939. The patent states, beginning at line 32:

"The invention is based on a discovery that acid solutions containing metals with or without so-called pickle control substances"—I would emphasize "with or without" —"when brought into contact with iron and steel automatically form a deposit or protective coating on the inner surface of the container which acts to prevent the acid solution from attacking the container."

Now, knowing from my early chemistry that metals like, for instance, copper in solution as copper sulfate, deposit on iron, I would wonder whether that was a discovery of Gravell's.

The patent then states that metals which have that property are below iron and above mercury in the electromotive scale. Now, the common metals below iron and above mercury are antimony, arsenic, bismuth, cadmium, cobalt, copper, lead, nickel, thallium and tin.

Mr. Owen: Now, was it your understanding when you first read this patent that the patentee intended to make any distinction or differentiation between the protective action to be afforded by these different metals? A. Well, up to this point, as I have read the patent, I see no distinction, but a little later on he expresses a preference for arsenic and tin. That is, he seems to use arsenic in his illustrations and he also seems to use tin and gelatin, about line 101 or 2. But that, as far as I get the meaning of the patent, wouldn't exclude any of these other metals if they

lay between iron and mercury. It says that under certain conditions tin produces good commercial results, however arsenic in most cases is more satisfactory.

The next thing that puzzled me a great deal about this is the idea of pickle control substances or acid regulators. The list of acid regulators is long and there are a great many things involved. For example, nitrogen ring compounds. That terminology includes a very large number of compounds. We checked up on that in various monographs dealing with ring compounds. For example, I found thousands of them listed in these books. And then, also, I found a large number of pyrols and pyridine bases. I had wondered if all those had been used. I didn't know whether Mr. Gravell had tested those or not, but I thought probably he had not.

The next item that interested me was this example down here on line 83, organic bases a quarter of a gallon, hydrochloric acid .75 of a gallon. Now, organic bases are listed above from lines 46 and 47 on.

The Court: Are those all organic bases? A. No, they are not all organic bases, for instance sodium bisulphate is not an organic base, it is an inorganic compound, cyanides may be inorganic or organic cyanides; there is no distinction in the terminology used. The starchy materials in water wouldn't be organic bases. To an organic chemist, an organic base usually contains nitrogen. For example, methylamine is an organic, having a methyl group, the nitrogen and two hydrogens, and there are a large number of those compounds in the aliphatic, as well as the so-called aromatic nitrogen compounds.

Now, going back to this example, I would like, for convenience in referring to it, to label these different examples in here with letters, for instance, the first one "A," the second one "B," and so forth, up to the letter "G."

In the example at line 24, where it says organic bases, why, there is no definite organic base mentioned there, so that means that I may use methylamine, I may use aniline, pyridine, or I may use mixtures of those, or mixtures of

different organic bases. But to me that example is somewhat indefinite. However, it is not indefinite to the extent that it means a starchy material, or anything like that, that is an organic base that is definite to the extent that it should be a nitrogen compound. A great many of these bases have an alkaline reaction in water solution, that is, if you add some of this methylamine to water, and test that solution with litmus paper, it will give an alkaline reaction.

Now, another thing about that example is that it says "hydrochloric acid," and that would mean to me any concentration of hydrochloric acid from 1 per cent up to, say, 35. And it says that that mixture must be shipped in glass, and it is to avoid shipping that material in glass that Mr. Gravell indicates in the next example, Example B, that he adds arsenic trioxide, .125 barrels. That "barrels" is obviously a misprint, and I think should be "pounds," because I don't think he intended to put barrels of arsenic in. "—the material may be shipped and stored in steel drums due to the protective coating formed, precipitated or deposited on the inner surface of the drum. Although arsenic plates out, the organic bases are not affected sufficiently to make any difference in the commercial use of the material."

I would take that to mean if he had the organic bases and the acid, that the arsenic would plate out of that particular mixture, and that that did not interfere with the use of the material later. That is what I take it it means.

Now, the next example, dilute phosphoric acid must be shipped in glass or rubber lined containers. But if you add to it an organic base and arsenic, to that material, it may be shipped in drums. Now, there is one great difference between Example D, starting line 24, and Example B up on the top of page 2. You notice that your ratio of organic bases is very high in Example B and very low in Example D, so that means that in this particular case there is a range of concentration, and he says that that doesn't interfere with the use of the material in its intended use.

Now, starting line 34, it says: "The proportion of

arsenic and organic bases may be widely varied in the admixture." Well, you have got in those two examples, B and D, you have got a wide variation, and it says: "—and the amount of the admixture added to the solution may be extensively varied, depending upon individual taste and commercial requirements." I would take it from that that the concentrations of material which Gravell intended to use could cover a wide range of concentration, within the limits that he has set up here in these two examples. Then I could go on with that same story about the other examples, but I think I have made the point clear.

Then, in line 76: "The admixture itself may be shipped safely in steel drums and it constitutes a satisfactory acid regulator or pickle control, because much of the arsenic is precipitated on the inner surface of the steel drum, leaving too small an amount behind to interfere with the commercial use of the acid regulator or pickle control."

That raises in a chemist's mind the question of, well, what amount of arsenic from these different examples is in the solution, and what amount is left in the solution which would be used commercially. It says:

"Or the admixture may be added to solutions of sulfuric or hydrochloric acid in sufficient amounts to prevent the solutions from attacking steel drums."

Then, in line 93 it states that: "Various modifications of the invention may be practiced without departing from the spirit of the invention, for instance, a steel drum may first be coated internally with arsenic and then filled with an acid regulator or pickle control solution, or acid solutions, containing an acid regulator or pickle control need only the addition of the proper metal, for example, an acid solution containing gelatine needs only the addition of tin."

Now, there is only two ideas in this paragraph here, but the first one is that you can coat the drum internally with arsenic. Now, he doesn't tell you how to do that, in so many words, but from what precedes you might assume that one is by putting the arsenic in the acid and putting that in the drum, and that would coat.

Then the next statement, if you have an acid solution which contains gelatine, you can add tin to it, and in that way get an admixture that is similar to those in the examples above.

Mr. Owen: How widely do the proportions of arsenic vary in examples B, D, E, F and G, as you have identified them? A. Well, they vary between about .0044 per cent up to about 1.72 per cent.

Q. Now, does the patent disclose to you anything that might be adopted as a standard for determining whether or not a solution must be shipped in glass? A. Well, the first example that I call A in column 2, about line 83, which consists of organic bases a quarter of a gallon and hydrochloric acid three-quarters of a gallon, it is stated that it is a mixture that must be shipped in glass, and the statement is clear.

The Court: By "C" I understand there a quarter of a gallon of 85 per cent phosphoric acid. A. That is correct, it is 85 per cent phosphoric acid and 15 per cent water, as I understand it in that table. You add to three-quarters of a gallon of water more, making a solution of phosphoric acid of approximately 30 per cent concentration, which he states is so corrosive that it must be shipped either in glass or in rubber, or rubber-lined containers.

Mr. Owen: Well, now, from these two formulas, "A" and "C," which the patentee states must be shipped in glass, can you find any standard of comparison whereby to ascertain whether or not a given solution would come within the terms of the patent if it contains organic bases and arsenic or some other metal than arsenic? A. Yes, I think that either the 30 per cent phosphoric acid or this organic bases mixture would be a fair standard of liquid which Gravell considered corrosive and whose corrosiveness he was trying to reduce by application of his metal salts.

I have conducted a great many tests with combinations of materials including acids and metals and also including acids, metals and so-called pickle control substances.

Mr. Owen: Now, have you prepared tables and charts showing results obtained in your tests? A. I have.

Mr. Owen: I offer this book of tables and charts as PX-343.

(The book was thereupon marked PX-343.)

(The witness then explained the data on these tables and the figures on the charts in part as follows:) Instead of taking the first table, I would like to turn immediately to the graph which is the next part of the PX, and the title of this graph is the "Rate of corrosion of mild steel in various concentrations of hydrochloric acid solutions containing 0.0043%, 0.102%, 1.32%, 4% copper chloride." To the left on the graph the legend is "Corrosion rate in pounds loss per square foot per day." Now, the corrosion rate of 35 per cent raw acid, the percentage being across the bottom of the chart, shows a corrosion rate between .60 pounds and .72 pounds. That is, the most concentrated hydrochloric acid has that corrosion rate. Now, moving down in concentration of hydrochloric acid, we find that at a concentration of 30, we have a point where the rate of corrosion is between 1.32 and 1.44 pounds per square foot per day. Moving back to 25 per cent concentration, the rate is 1.32 pounds per square foot per day. Coming down to 20 per cent concentration, the rate is between .48 pounds per square foot per day and .60 pounds per square foot per day. Coming down to 15 per cent, the rate is between .24 pounds per square foot per day and .36 pounds per square foot per day. Down to 10, the rate is a little less than .24 pounds per square foot per day, and at 5 the rate is about the same. Now, that particular set of data shows that different concentrations of hydrochloric acid have different rates of corrosion. Now, when I add copper chloride to that in an amount of 4 per cent, it accelerates the corrosion enormously in the case of the 5 per cent. It does the same with 10 and it does the same with 15.

Q. Is that shown by the dotted line? A. That is the dotted line, so-called number 1, down here. And it goes over, as the concentrations of acid go up, it becomes less than that of raw acid. The legend for that is on the right there. The dotted line is the 4 per cent copper chloride.

Now, if we take number 2, that is 1.32 per cent copper chloride, and number four is .102 per cent copper chloride, and if we take the lowest amount of copper chloride, the 0.0043 per cent copper chloride, we find that it is the most effective concentration of copper chloride to use in hydrochloric acid, compared to, say, the 4 per cent. Now, this is an entirely unexpected result as far as I am concerned. That is, why less copper should be more effective in hydrochloric acid of different concentrations is a point of interest.

Q. Now, Doctor, do these amounts of copper chloride shown in these different curves have any significance in connection with the Gravell patent? A. They are concentrations selected from the patent examples except the 4%. There is no concentration of 4% mentioned by Gravell.

Q. As I understand you these are the percentages of arsenic contained in the different examples, and you have used the same amount of copper in making these curves, is that right? A. That is correct.

Q. And can you identify with the examples which you have marked A, B, C and so forth, in the patent, these different figures so we will have that? A. Yes. Example D which contains arsenic contains 0.102, Example B contains 1.32, Example F contains 0.0043%, Example G contains 1.43% arsenic.

Q. The Example G is not on here then? A. No; Example G is 1.43%. That is not on the chart.

Q. So that the ones on the chart are B, D, and F? A. Yes.

Mr. Lyon: Let's put them on by number, Mr. Owen, will you?

Mr. Owen: No. 2 curve is Example B. No. 4 curve is Example D. No. 5 curve is Example F.

Q. Now let's get back to the table which is the first sheet in this exhibit PX-343. A. In that I have calculated the corrosiveness of these different amounts of copper chloride in the 5% hydrochloric acid. Taking the 5% hydrochloric acid as 100% corrosive it has a rate of 0.174 pounds per square foot per day.

The Court: Where is that? A. In the top line, Your Honor. That is 5% hydrochloric acid without any copper, and has a rate of 0.174 pounds per square foot per day. Now, when I add 0.0043% of copper, the corrosiveness is reduced to 62.7; if I add 0.102% of copper, the corrosiveness is reduced to 68.3. That is the third line in that group. I am reading only the right-hand column.

The next one where I go up to the 1.32 per cent of copper, instead of having a reduction of corrosiveness, I have a definite acceleration of corrosiveness; and the corrosiveness has about 129 per cent that of the raw acid; and when I go to 4 per cent of copper I have got 336 per cent corrosiveness, or, my corrosion runs three times more than it was in the 5 per cent raw acid alone.

The chart, of course, shows the same data, but it is rather hard to read these figures from the chart, and anybody looking down through the columns can see how it varies in these different concentrations of acid.

Q. I note that in the data in connection with the 10 per cent hydrochloric acid, the effect of the different amounts of copper chloride were the same in order as in the 5 per cent group? A. That is right.

Q. But when you come down to 15 per cent hydrochloric acid, then it seems that the additions of any of these different amounts of copper chloride reduces somewhat the corrosiveness? A. Yes, that is correct.

Mr. Lyon: When you get down to 35 per cent, they go in the other direction? A. That is right, and the graph shows that.

The Court: Those that you have just been reading to me are shown by which line on the graph?

Mr. Owen: We have been reading all of the lines on the graph, Your Honor (indicating). It seems harder to follow on the graph than it does on the table? A. That is right. That is why I provided both the table and the graph, because that makes it easier to make some of the comparisons.

Q. Doctor, how many different strip tests did you

make for each of these different concentrations of these acids? A. Well, we made for any point that we show we made three tests; for many points we made 5; and for other points up to 20. It would be impossible to recall just how many we made in any specific case.

Q. These figures that you give in the last column, and in the next to the last column in each of these tables are the averages of those results? A. That is correct.

Mr. Lyon: Have you plotted the averages in making these curves? A. That is correct, Mr. Lyon.

Mr. Owen: I would like to have Your Honor turn back to the first chart, showing the corrosiveness of the different concentrations of hydrochloric acid, and I will ask the witness to point out the most corrosive concentration, and state how the corrosiveness is affected by either higher or lower concentrations from that point. A. The question asked me, where is the most corrosive mixture of the hydrochloric acid, and my answer is that it lies somewhere between 25 and 30 per cent, or a little on both sides of that, that is, I haven't got too many points here, but I have done this often enough to know that that is the data I have.

Q. Doctor, I think you misspoke yourself, you said the most corrosive point was between 25 and 30; isn't it between 30 and 35? A. Yes, but I qualified that by saying my high point is a little above 30; before I would want to be real precise on that I would want more tests. There is no question in my mind of the general phenomenon, but to say that it is precisely one concentration, that is another point. It is in that region.

Q. Now, I want to have you trace this corrosiveness line for raw hydrochloric down to the 15 per cent concentration, which is the one in which we are particularly interested in connection with the Grebe-Sanford patent. I will ask you to state the corrosion rates for 5 per cent, 10 per cent, 15 per cent, and 20 per cent hydrochloric acid. A. The corrosion rate on the 5 per cent raw hydrochloric acid is 0.174 pounds per square foot per day.

Mr. Owen: Does Your Honor know where that comes

from? It comes from the left, those figures on the left. That is at a point between the 0.12 and the 0.24 on the chart.

The Court: All right. A. (Continued): And the exact value is 0.174 pounds per square foot per day. For the 10 per cent hydrochloric acid the corrosion rate is 0.190 pounds per square foot per day. For 15 per cent hydrochloric the corrosion rate is 0.263 pounds per square foot per day.

Mr. Owen: And Your Honor will notice from that point on it begins to go up pretty fast.

The Court: Pretty fast. And it drops off. A. Yes, sir. It drops off on the further side very definitely.

The Court: Yes.

The Witness: The graph C-1658 shows the effect of arsenic in raw hydrochloric acid, when the concentrations of the acid are varied. Now, this graph is similar to the graph on the copper, and you will notice that the raw acid again is the solid line. You will notice that the two low concentrations of arsenic trioxide follow pretty well along with that of the raw acid. No. 1 is the raw acid. The solid line, Your Honor. 2 is the 0.0043 arsenic trioxide; 3 is 0.102 per cent arsenic trioxide. Both of those concentrations, you see, follow along pretty well with those of raw acid, over this concentration range, which is from 5 to 35.

Mr. Owen: In other words, they are not very effective? A. That is what the curve indicates.

The Court: One of them makes it worse and the other a little better? A. That is right, up on the top point.

Mr. Owen: Now, when you come down to 4 and 5, what are those concentrations, and how effective are they? A. No. 4 is 1.132 arsenic trioxide. It is effective except up around 20 per cent. And 5 seems to be somewhat effective, because the corrosion rate now is less than 0.06 pounds per square foot per day, whereas up at the high point on the low concentrations we have the corrosion rate of about 1.44 pounds per square foot per day.

The Court: Well, No. 5 does the best job of all? A. Well, 4 isn't very much behind. They run pretty close. It is a horse race between the two of them.

The Court: I wonder if I could find some theory—when you get an answer that has a very low corrosion rate, you are more likely to get an increase than you are with a high one, isn't that so? A. Your Honor is a braver man than I if you wish to theorize about this data and corrosion rates. I am going to stick to facts. If I get messed up in theory here, I will be at it a long time.

The Court: All right. I agree.

(A volume of Alquist's tables marked PX-344 was handed to the witness. Referring to the table entitled "Corrosion accelerated by the addition of a Gravell metal to a 31.45% hydrochloric acid solution (20 Be') containing the acid regulator indicated," the witness testified:)

This table gives data on 31.45 per cent hydrochloric acid, with an acid regulator added, and I will have to explain about this particular acid regulator. Referring again to the testimony of Mr. Douty, at Ambler, he stated how bone oil is extracted with hydrochloric acid, in order to get a mixture of organic bases in hydrochloric acid, which is a mixture of organic bases in acid. Now, this bone oil was made in that way, that is, it was extracted with hydrochloric acid, the tar removed as described by Mr. Douty previously, and that clear acid solution, that is, clear from any oil, and so on, as well as that can be separated so that it was suitable for use, it was dark in color, and when I say clear, I mean clear of the oily layer, which we removed, and that organic base mixture was added in hydrochloric acid, which I call in the table 0.1 per cent hydrochloric acid bone oil extract. You take the bone oil and extract from it by means of acid the soluble portion, and discard the insoluble portion. When I add that to the acid alone in this percentage I get a corrosion rate of 0.5834 pounds. Now, in all this table the raw acid is 20 Baume.

The next example we used again a tenth of a per cent of hydrochloric acid bone oil extract, with 0.228 tin, and the corrosion rate increased to 1.189 pounds per square foot per day, which is double that of the preceding example. In other words, a lower corrosion rate such as the patent would

suggest in this hydrochloric acid, I got a higher rate of corrosion with this particular admixture. If I add cobalt, I get an increase in corrosiveness in the same mixture of bone oil extract and raw acid with the bone oil extract added thereto. The corrosiveness of that mixture is about 50 per cent to 60 per cent more than that of the first example.

Then I varied the amount of the bone oil extract, increased it to a half per cent, and when I added more of the bone oil extract, I got a decrease in corrosion, and my rate was 0.3277 pounds per square foot per day. If I added 0.228 per cent tin the corrosion rate went up slightly to 0.3606. Now, this data is graphically presented in graph No. C-1748.

The Court: You take away down at the bottom there, where you added 0.5 hydrochloric base, you say it reduced it, you mean comparing the— A. Comparing it to number 1 above in the same table, Your Honor.

The Court: Now, I am not taking the time to look back, but just asking you, how does that compare with the 20 Baume acid alone? A. Well, the 20 Baume acid alone has a corrosion rate, as shown on my graphs yesterday, of 1.41 pounds per square foot per day, compared to this 0.5834 for the—

The Court: In other words, just add that bone oil extract? A. Yes, sir, the hydrochloric acid bone oil extract.

Q. What is bone oil extract? A. Well, as Mr. Douty explains, if you distill bones in that process, you get an oil which is a mixture of a large number of nitrogen compounds, some of them organic bases, some of them organic nitriles, and there are a large number of things in that mixture; that is the bone oil alone.

The Court: That does a better job of inhibiting than a lot of things you had? A. That is true, sir.

The Court: I was curious about it: is that an acid? A. No, that is a mixture of organic compounds. You cannot call it just an organic base, it contains organic bases and it contains organic nitriles, and, for instance, this contains the methylamines, which was one of the amines I mentioned yesterday.

The Court: Have you played with these things enough to tell me if I reduced that down to a half of one per cent, this bone oil extract, suppose I took a quarter, cut it in two again, where would you expect it to go? A. Well, if we varied that amount of bone oil; I think we will find some of that data further on, and I would rather go to those facts than try to clarify that picture, except to say in a general way—

The Court: I haven't found anyone that dared to say anything about these things unless they have run the tests, and I am talking generally about all these subjects, isn't that true, isn't that a correct conclusion? A. It seems to me we have difficult problems.

The Court: And they are justified in it, which seems to show that there isn't much—generally you say if you take twice as much you get at least more of the results you are aiming for, but you are liable to get less. Here I take half as much of this bone oil mixture and I get a greatly reduced— A. No, Your Honor is not quite straight on that point.

Q. (By Mr. Owen): You take five times as much? A. The first one is a tenth of a per cent; I would like to point that out right on your table, so I will make myself clear; that is one-tenth and you take five times the other.

The Court: That is right, that is right; when I add it, it went the right way. A. Yes, for once it did.

The Court: I am glad, I was wrong, and I thought you had taken a half. A. No, sir.

The Court: I got my decimal point wrong, five times as much. A. Yes, sir.

The Court: Well, then, I will just repeat the question the other way; suppose you take one per cent instead of a half a per cent, would you expect it to go on and get better? A. Yes, sir; I will have data like that in the future, I believe, if we haven't taken that particular data out here in streamlining.

The Court: Then as to that one subject it seems to go, but now I was going to go back over here to the first

column, you see. Suppose all of those experiments there had been performed with 15 per cent of hydrochloric, what kind of result would you expect? Of course it would change your standard; that first one is your standard. In other words, what I was really getting at is whether you thought the bone oil acid would have a decidedly different effect on 15% than it would on the other. A. No, they would be both in the same general direction, Your Honor.

The Court: You would take that all the way down too? A. Yes, your corrosion rates in general would be lower. I might get acceleration or might get decrease with the metals added. I would have to see the experiments.

The Court: If I carried it on below they don't keep following down, or if I went up with my hydrochloric percentage it doesn't run uniform from one to 100? A. No. You can't quantitatively calculate from looking at one set of figures what you would get from the other.

The Court: Well, I come over into my middle column here. You think if I increase all of those I would get a better or a worse job? A. Well, I will only refer to my curves on copper. Yesterday I showed when I increased the copper percentage I got very much higher corrosive rates in certain instances, with copper in hydrochloric acid.

The Court: Would that be true of this, you think, as it was for copper? A. I don't know without doing the experiment. But if it was like the copper, then they would go up. If it was like the arsenic, then they would go down. I don't know. I would have to do the experiments. I have some of these experiments further on here.

The Court: I was not criticizing you because you hadn't made enough experiments, but what I was really aiming at was whether there was any formula or theory growing out of this? What is the theory out of the first page? I have a lot of figures. I seem to understand each one as I look at it, and as I look at the one above and the one below, and up here, and I seem to understand it, but when I get all through, I wonder what I have got. You gave me a— if you had a conclusion growing out of these

experiments, what is it? A. Well, I will say it this way that the behavior of these mixtures is unpredictable, and the only way I know of getting to the facts is to make enough experiments to try to make the picture as clear as possible and I would rather go on with the data and come back to that point later if I may.

The Court: Well, now, I have seen so many of these things that I will agree with you—you say if you add one-half per cent butanol you get that, but how do I know if you add more or less, or if you add some other alcohol—that is an alcohol, is it not? A. That is right.

The Court: If you add some other alcohol,—the way these things are going, I just know the ones that I see, or, the one that I see there, and I cannot depend upon his cousin to behave like he does at all. It seems like there are black sheep in the family, and some who distinguish themselves, among a lot of ignoramuses. This is a funny family. A. I have been working on the subject for eight years, and I still do not know all of the points about these things; they are very complicated.

The Court: Now, this occurred to me, how do these acid regulators—they can be divided into different classifications, can't they? A. Yes, sir, and they have attempted to do that.

The Court: Have you been able to work out any classification, general description, according to well known classifications that will tell which are helpful and which are harmful, and which are most helpful; is there anything like that at all? A. Well, I might be proven wrong in some cases, but I will try to answer that question, referring to this chart of Mr. Rebbeck's, talking about what I think is present-day practice, realizing that I do not know all of the different present-day practice. For instance, I would say from my knowledge that the acid resins are very little used in present-day practice. That is No. 7 on the third column of Mr. Rebbeck's chart.

The Court: Well, you are just going to point out the particular ones that are good and bad. I was wondering if

there was some description by metals that were black or white or heavy or light, or ductile or not ductile; is there any general description other than by going right through and putting your finger on something by name. A. Well, I give this as an opinion, and I even hesitate to do that—

The Court: I can see why you do, because no one has stuck their head up in the lawsuit that someone else hasn't been able to knock it down. A. Well, I would say from considering present-day practice, and making it brief, that in general we find that the things on the market that get the use are either in the class of nitrogen compounds or sulphur compounds, or sometimes combinations of those.

Q. (By Mr. Owen): Those are on the market for what purpose? A. For pickling inhibitors. Now, I might be proved wrong on that point; that is just my own personal opinion, and I don't know whether, as I say—

Q. Now, on this chart, PX-337, which items would cover those pickling compounds you have referred to? A. Well, they would come under 22.

Q. That is pyridine bases? A. That is correct. That would be the nitrogen compounds, then of course organic bases are also nitrogen compounds.

Q. That is No. 21 on the chart? A. So I would have to include 21, and I do not want to leave out 20, you see the thing starts to expand.

The Court: Do you mean good to use with metals or good to use all alone? A. I am talking about good to use all alone, which is the practice that is most commonly followed at present as far as I know; there may be some practices where they use the metals. Now, the sulphur compounds here, I don't find them stated exactly, some of them are used.

The Court: Now, when we come to talk about using them with metals, do some of them, some of these that you have in your list that are good to use all alone, help metals? A. Well, the answer to that is the experimental data with the strips seems to show there is a helpful effect, as I have already pointed out on the chart this morning.

The Court: I will put the same question putting it the other way around, and ask would metal help some of them? A. That is the same question; you have the acid with these two things added to it.

The Court: Aren't some of them harmed? A. Some of them are harmed and some of them are helped.

The Court: If it goes for one, it goes for both again, if you put the metal in, or does it, do some of them make the metal better, do a better job than the metal, but not so good as they would do alone? A. Well, the phenomena goes all ways, as that chart shows. For instance, in the chart this morning I showed you where adding some of these organic bases to the arsenic it made it worse, and I showed you cases where it helped, and I even showed you cases where it was better than sulphuric acid.

The Court: Now, there are two questions in that, those that you say some of them make it better and some make it worse, is that result you might be speaking of either the metal or the organic base and it might help—the combination might be better than one and worse than the other; some of them will fall that way, won't they, in between? A. That is right.

(A volume of Alquist's tables was thereupon marked PX-355.)

Mr. Owen (handing PX-355 to witness): Please explain briefly what this data refers to. A. PX-355 refers to tests made on a half gallon container. It is shown in photograph 77,140 in the exhibit and is lacquered on the outside, made of 28-gauge metal, black iron.

The Court: That is something that you made? A. No, I bought it on the market. It is made by the Central Can Company of Chicago.

The Court: It isn't anything that has been used in the oil business here? A. No, but it is a container, as far as I know.

The Court: Yes, it is a container all right.

The Witness: In these half-gallon tests we used 1600 c.c. of the acid, the acid with an acid regulator, or the acid

with the metal salt or the acid with the metal salt with the acid regulator, combinations that we have previously been discussing. Now, these tests were run with the cover laid on the can. In other words, it was vented. So that if there was corrosion, if the iron did dissolve, the hydrogen gas did form, the hydrogen gas could escape and the corrosion continue to take place. Now, the tests are arranged, again, in order—I ran approximately 200 tests. By that I mean more than 200—I don't remember the upper number, and these tests are summarized on these tables and the graphs which accompany the tables.

One time when I had a few minutes to spare I figured you could run about five billion tests on this blooming patent.

(The witness then explained his ½ gallon tests in connection with the tables, graphs and photographs in PX-355.)

(The court thereupon inspected a number of half-gallon drums.)

The Court: I will just put this on the record: I have examined a large number of these half-gallon containers that have been eaten by the acid in them until they leaked, and in practically every instance I can find that that was the weak point in there, by the structure of things, in other words, they are very likely to be where the weld was. They are very likely to be in the seam where the bottom is fastened on in some way, and in one I found that it was not in the seam or in the weld, and it ran decidedly straight down the side, and when I came to examine it, I could see that in some way when that was made there is a seam at that place, or some kind of a damage, and, of course, that isn't surprising to us, because we all know that there can't anything be made like that that doesn't have some spots weaker than others and more subject to attack than others, and so that doesn't explain anything, unless, in a measure, why some of them would, because of their structure, go quicker than others. But we have enough of these experiments so that I think it is safe to say that we can see that

the acid and the inhibitor that was in it had much to do with where they would go to. It isn't all, by any means, explained, in my judgment by just the difference in the metals of all of these. They are as near alike as commercial containers are turned out. I am satisfied they furnish no more multiplicity of strength and weakness and variations of that kind than would be found in commercial containers. Has anybody anything they want to add to the record?

Mr. Owen: I thought that we might mention that in some of them the metal had been eaten away,—

The Court: Yes, in some of them where I have mentioned—in all of them I seem to find that if they leak they had been eaten in seams or defective places. I will say in addition to that I found one that not only leaked in the seam but right through the bottom at numerous places, there are openings that I can see the light through, so that that one it seems evidently held about as well as the rest of it, because it went at both places, began to leak before they took it out, it had eaten enough so it was leaking not only in the seams but right through the bottom in numerous places, and that one, for example, showed that it did go very evenly, because the walls of it, where it is not eaten through, as I feel of it, are as thin as paper. It feels like a piece of ising-glass to my hand as I bend it back and forth and it cracks like a piece of ising-glass would. It is so thin I am satisfied that that one, for instance, if you weighed the before and after this would show a very great reduction in weight, because it went like the old one-horse shay, everywhere.

Mr. Lyon: It might be interesting to have the record show that is the one you just referred to, No. 191.

The Court: 191.

The Witness: Now, before I continue, I probably should explain that I ran half gallon tests, ten gallon tests, and 55-gallon tests, and there are different containers, so there can be no possibility of any mistakes in the work on what the drums are concerned with, I used a system of designation, say ½ number 36, ½ number 10, and so forth.

and on the 10-gallon it was 10-52 and 10-54 and so on, and on the 55's it was the same way. So that would avoid any confusion, if it would possibly occur, which is slight.

The next graph, C-1796, was tests run on 15 per cent sulphuric acid, and with 15 per cent sulphuric acid, one-tenth per cent cadmium sulphate, one-tenth methanol, the life continued for less than 20 hours. With one-half per cent copper sulphate and one-tenth per cent butanol, it lasted a little longer than 20 hours. With one-tenth per cent cadmium it lasted about 35 hours. One per cent cadmium with one-tenth per cent dimethylamine lasted a little over 40 hours. One per cent cadmium phosphate—I mean cadmium sulphate lasted the same length of time.

Q. (By Mr. Owen): And the addition of dimethylamine had no effect? That is, 7 and 8 are the same, except 7 had the one-tenth dimethylamine? A. That is right.

The Court: Except we must keep in mind now that if this difference does come in the container, for instance, there where they are close together like that, they might be just reversed. A. Yes, but you remember that is the problem Gravell purported to solve, sir.

The Court: Yes, I know, but I say the— A. (Interposing): He was faced with his containers, and if they were iron containers, they had these properties at that time as well as on my tests.

The Court: For instance, they are close enough together so that the one per cent cadmium sulphate in number 6 and number 7 might have been reversed sometimes in your tests, I take it? A. That is right.

The Court: I just was calling attention to the—how with the same test they jump around so widely. A. That is right. I have shown that repeatedly.

The Court: And that is all fair on your part.

Q. (By Mr. Owen): Doctor, I would like to ask you right in connection with the remarks of the court, whether the character of the corrosion in these various drum tests was the same, in other words, was it equally eaten all over, or was it a different type in some places? A. Well, Mr.

Owen, I dislike to answer that question without having carried out more detailed observation. Now, for instance, I can find one like His Honor mentioned, where it crumbles all down all the way around, and it has been eaten out quite badly, and you can definitely say there has been an even type of corrosion. But where you weigh one up and don't make the determination of just where that much of the weight is, you would have to be indefinite on that point. For instance, what are you going to say, you have one that goes out two hours, ping, and in one certain spot, and that is all. That don't have much chance to corrode evenly all the way around. It corrodes all in one spot and is gone. That is one of the things in Gravell's problem.

The Court: The one that went out quickly probably didn't reduce in weight as much as though it had gone a long time and ate more evenly. A. That might be.

The Court: Probably. A. Sometimes they might not, but these, some of them, lasted a long time and had small losses in weight and just pinged out in one spot.

(A book of tables, graphs and photographs relating to the 10 gallon and 55 gallon tests was offered as PX-356.)

The Court: I never saw so many tests in my life.

Witness: Well, what is a fair sample of five billion, Your Honor?

The Court: I don't know. I would answer like so many have. A. I would say that too; I don't know.

(Witness continuing): Now, the first part of this book contains the Interstate Commerce booklet description of the containers which they call the 5A container. This container I am going to describe in the tests is shown in Photograph 77142. I have one over here (indicating) and that is called the 10 gallon I. C. C. 5A Drum. The next photograph is one of the test chambers which I used to conduct these experiments in. When I started out on these tests I would fix up the drums with the gauge on them, as suggested by Mr. Douty previously, and placed the containers in what we call the fume cupboard in the room and let them do their stuff. It happened one night one of the boys tak-

ing care of the observations for me went in there, looked at the pressure gauge, made a record, and just as he walked away the drum let loose, knocked the door of the fume cupboard loose and after that he was chary. He told me in no uncertain terms I better fix it up better for him. So we constructed a special chamber in which we have taken out some of the hazard of this operation.

The Court: Sounds like one of those bomb-proof cellars.

(Witness continuing): This room was constructed with the heater in the position shown in the top of the photograph with the light in the same position, situated as far from the testing drums as we could, so I wouldn't overheat the drums. I tried to hold the temperature at 35°C. the same as I did the others.

The Court: What is that Fahrenheit? A. 95°. And then I put my liquids in the drums and then attached the small pipes to the drum and then put the pressure gauges which the boys had to read on the outside as shown in the next photograph. The photograph, which is 76645 shows one side of my drum hut, as I will call it, with the pressure gauges on the outside. You can see there are six pressure gauges, and then the thermal couple coming out of the middle run goes behind, a continuous record for the temperature.

The Court: I take it we are getting ready to make a test of acid pressure in a steel drum? A. That is correct. And the door on the front of this drum hut was made out of safetyglass so we could look inside and see what was going on. That is at the bottom of the photograph as it is placed in the book here. I should say so I will not be misunderstood, these photographs were taken with no acid mixtures in the drums. We didn't wish to expose the photographers to any danger. This shows the setup before it was actually used.

I would like first to refer to photograph 76735, the first one right before the first table. That gives you some indication of what happened on some tests when these drums

let loose; this door, you can see there (indicating), they were so set that they could let loose without taking the shanty with it, that is, break the door. You can see that the pressure is off the gauge, and you can see the gaping open hole in the bottom of the can as it lay in the doorway. The container was like this one here (indicating), pretty heavy. It weighs about 25 pounds, holds about 10 gallons of acid, and is 16 gauge metal.

(The witness then explained the tables, graphs and photographs in PX-356.)

Drum 10-68 failed in three-quarters of an hour. The pressure reached 38 pounds. It leaked in the bottom seam. We have a graph of that which I will refer to. The graph says Drum 10-68, the acid was 20 Baume hydrochloric acid, there was no metal added, no regulator added, the drum failed in ¾ of an hour. The average temperature was 35°C. The graph is No. C1545-A, and the pressure went from zero pounds to 38 pounds in that 45 minutes. The curve in the graph is the pressure curve. That shows how that pressure went up. For instance at the end of about 30 minutes the pressure was over a little less than 30 pounds.

(Referring to the table on page 37 of Exhibit PX-356, entitled "10 gallon drum corrosion tests with 20° Be. hydrochloric acid plus metals and acid regulators" the witness testified:)

The next group of tests is 10 gallon drum corrosion tests with 20 degree Baume hydrochloric acid plus metals and acid regulators. Now test on drum 10-65 contains 0.21% cobalt and 0.5 normal butanol. The drum failed in two hours. The maximum pressure was 62 pounds, and it leaked in the bottom seam. Another test was 10-64 with 0.23% cobalt and it had .5% normal butanol, an alcohol. It failed in 2 hours. The maximum pressure was 66 pounds. On drum test 10-92, it contained 1.05% tin and 0.3% gelatine, and this first drum lasted 5.2 hours and had a maximum pressure of 52 pounds. There is another one at 0.105 per cent tin against 0.3 per cent of gelatine, and this lasted 5.5 hours and the maximum pressure was 57 pounds. The

first one, the head blew out, and the second one leaked at the bottom seam.

You will recall that Mr. Gravell in the patent makes the statement that he prefers tin or arsenic. He makes that statement on line 43, and also makes that statement in the paragraph beginning with line 98, "or acid solutions containing an acid regulator"—in this case my acid regulator is gelatine. It has been known for a long time that gelatine is an acid regulator for pickling material. Then he says, it needs only the addition of tin. I tried to do what he says, in one of his preferred examples, and my drum lasted for 5.5 hours. My next test was 10-78, with 0.22 per cent nickel and 0.1 per cent hydrochloric acid bone oil extract, and the drum lasted 11.6 hours. The maximum pressure was 55 pounds, and it leaked in the bottom seam. And this hydrochloric acid bone oil extract is an organic base admixture. The next one I added 0.24 of a per cent tin to this hydrochloric acid bone oil extract, it lasted 12 hours, and the maximum pressure was 53 pounds, and it leaked in the bottom seam. The next test, 10-77, I used 0.16 per cent cobalt with a tenth of a per cent of hydrochloric acid bone oil extract. The drum failed in 16 hours. The maximum pressure was 57 pounds, and it leaked in the bottom seam.

I might mention what I mentioned before, and say this, that if you look back in your first table you will find some of my low numbers, and I told you that I had the drums on their sides, and I would not be surprised if around these bungs, and so on, where the metal is more strained, it would be more apt to corrode. That is one of the theories they use, but I don't go so much for theories. I would rather have it in practice.

By Mr. Owen:

Q. How were the drums located in these 10 gallon tests? A. In all these tests, the conditions were more uniform than in the earlier tests. But in shipping you do not have them always in an upright position, you may have them in any kind of a position.

Drum test 10-83, I used 0.21 per cent tin. That drum

lasted 17.4 hours. The maximum pressure was 64 pounds, and the head blew out. The next one had 0.24 per cent tin, that is drum 10-84, it contained 0.5 per cent of hydrochloric acid bone oil extract, it lasted 24.6 hours, the maximum pressure was 55 pounds.

The Court: I call attention to the fact that when we had the same amount of tin up above without this, it went out in 12 hours, practically half the time that it did with the increased amount of bone oil, the bone oil when it was one per cent it went out in 12 hours, and when it was 5 per cent — A. It is one tenth and five tenths.

The Court: One tenth, yes, but the increase of bone oil is the only difference I can see there, the tanks held about equally well, they went out at the same pressure, about? A. That is right.

Mr. Lyon: An extract is only partly bone oil, Your Honor.

The Court: Well, whatever that is, it was the same in both cases? A. That is right. It was the same batch of stuff made according to Mr. Douty's described process.

The next one we used 0.27 per cent cobalt, 0.1 per cent bone oil, and that drum lasted 25½ hours, the maximum pressure was 60 pounds, and the head blew up. Now, the next test, No. 10-90, contained 1.14 per cent tin, 2½ per cent by volume monoethylamine and 22½ per cent by volume diethylamine, the drum lasted 29¾ hours, the maximum pressure was 63 pounds, and it leaked in the bottom seam. Now, this particular mixture here is similar to that first one in the patent, that is a mixture which Mr. Gravell says has to be shipped in glass. That is the one-quarter by volume of these organic bases, you see that adds up to 25 per cent.

Q. That is example A, with tin substituted for— A. Well, it is example A, so far as the bone oil—I mean the organic base and the acid is concerned, and then when I am adding the tin, I am adding the tin in place of the arsenic in example No. B; is that point clear?

The Court: This is really B? A. That is right, it is really B, and when I was talking about the organic base

with the acid I said that was composition A, but that lasted 29¾ hours. I am sure I couldn't ship a drum of that to China in 29¾ hours.

The Court: How does this compare with the one without that added, though, where is that, that we would have to turn back for, you have that somewhere? A. No, I don't know whether I do or not; I will discuss that a little later when I show you the graph, and so on.

The Court: All right.

The next test, No. 10-89, contained 0.48 per cent tin and 0.5 per cent hydrochloric acid bone oil extract. The drum lasted 32.3 hours, the maximum pressure was 55 pounds. Test No. 10-76 contained 0.20 per cent cobalt, half a per cent of hydrochloric bone oil extract. The drum lasted 32.4 hours and the maximum pressure was 56 pounds. It leaked in the bottom seam. The next one contained 0.26 per cent arsenic and 0.0057 gelatine distillate. It lasted 563.2 hours, the maximum pressure was 54 pounds.

The Court: Old arsenic is the stuff, isn't it? A. Well, the drum failed.

The Court: It failed, but that was— A. That is 600 hours. It is about 15 days. I certainly wouldn't recommend the use of a proposition like that.

The Court: No, more than that? A. Wait a minute. It would be about 25 days. I haven't got my pencil. It is less than 30 days, I know that, because that is 720.

Mr. Lyon: It only had .3 per cent of arsenic in it. And practically no gelatine. A. That gelatine distillate is pretty hard stuff to make. It foams and sputters and fusses, and you can't buy it on the market. You have to make it yourself. I didn't have very much of it to test.

The Court: That held pretty near 28 days? A. That is right.

The Court: Run through February. A. And the next test was with .3 arsenic, the same amount of gelatine distillate, and it lasted 667 hours, and the maximum pressure was 46 pounds.

Now, I have some tests running now in which I put in

1.32 per cent arsenous oxide, 25 per cent by volume of Barrett's commercial pyridine base No. 2. Now, if you will recall my strip tests, that Barrett commercial pyridine base No. 2 was a mixture of commercial inhibitor sold on the market for such use. I am using one-fourth by volume of that as prescribed in the first example. I mean the first example on page 2 of the patent, which is a very high percentage of organic base, and I am using the same amount of arsenous oxide that is called for. And that test was started on the second day of July and it is still in progress, and I can't report the failure time. However, you can figure the time that the drum has been running by going through the 2nd of September, and that is about sixty days.

Mr. Lyon: 64 days. A. 64 days. Yes. But that stuff has sure got a lot of organic base in it. I certainly would not want to use that for anything except a pickling inhibitor. Those things you can buy on the market. They are one-third organic base of the pyridine type, one-third acid and one-third water. You can buy them on the market. And they contain no metal salts. They are just sold as such alone, and that is one thing about that test that I don't know the answer to. These organic bases last a long time by themselves. I get the arsenic in there and I don't know whether it is the effect of the arsenic or the effect of the organic base. If you go back to my half-gallon tests with the organic base admixture with acid, it lasted me, what was it, about 1440 hours, something like that.

Mr. Lyon: When you say those tests are still running, that No. 31, you mean that that stuff has been in the barrel, in those drums since the 2nd day of July and the drums haven't failed yet? A. That is right.

The Court: Haven't failed yet? A. That is right.

Mr. Lyon: Still in it? A. That is right.

Mr. Lyon: You have a pressure gauge on it? A. There is pressure on the drums.

Mr. Lyon: Well, how much? A. I looked at those drums this morning, and they are running along about five pounds pressure.

Mr. Lyon: Only five pounds? That is Mr. Arsenic operating with the well-known organic base inhibitor, isn't it?

Mr. Owen: Well, is it Mr. Arsenic operating? A. That is the question that I don't know the answer to.

Mr. Lyon: It has arsenic in it. A. Yes, but for years we have been buying bases with acids and waters in them in iron drums without any arsenic in them, ship them around and use them.

Q. (By Mr. Owen): In what? A. Ordinary drums.

Q. Name some of them. A. Barrett's pickling compound No. 3. 1/3 pyridine bases, 1/3 sulfuric acid, 1/3 water.

Mr. Lyon: Pyridine is not an acid solution. A. That solution is acid and I have tested it.

Mr. Lyon: Is pyridine a corrosive acid? A. I didn't say pyridine was. I said that is Barrett's description of the material we buy from them in iron drums all the time—it is regular commercial practice. Here I got a proposition of the effect of that high, high amount—that is a tremendous amount of organic bases. For instance in pickling practice they use very small amounts, less than 1% of the pickling inhibitor; that is common practice. They don't use 25%. This is a concentrated pickling inhibitor I have under test here. It is not comparable to the other tests. It was part of the patent and I wanted to have information on it.

Mr. Lyon: I would like the record to show this test has been running now over 1500 hours and the drums have not failed.

The Court: The point I am wondering about is you said you didn't think that would be good to use as a practical inhibitor. A. I just ask Mr. Lyon if he would shove that mixture down into an oil well.

The Court: I take it you say not. Why not? A. Mr. Lyon, would you shove this mixture 108 or 109 down into an oil well?

Mr. Lyon: I would have to ask my expert about that. I don't know enough about it.

The Court: For what reason? I know you have a reason. A. Yes, economically that admixture is much more expensive. The formula will function in the well. So from that point of view it can't be considered as an inhibiting acid. It is a pickling admixture. That high percentage of organic bases is a pickling admixture—1/3 pyridine bases, 1/3 sulfuric acid, 1/3 water. That is what they sell and what we buy.

The Court: You don't put anything down into the well that would do such a complete job of inhibiting? A. That is my opinion, sir.

The Court: What you are using wouldn't inhibit to the extent this does? A. That is another question.

The Court: Any of you. I didn't think any of you went to that extent. A. If you take the regular mercaptan inhibitor which we use, its corrosion rate is similar to this admixture here. We only use less than 1% of that.

The Court: I mean after you get it in it wouldn't come into this range? A. It will come within that range, Your Honor,—

The Court (interposing): If you put it into these barrels, wouldn't it have acted quicker than this? A. I have some data—I wouldn't want to be too precise about that, but I think that I could find it, but they will last somewhere in this same range.

The Court: There isn't anything in this record, is there, which shows the extent to which it inhibits?

Mr. Owen: The patent example is in the record. But there is nothing in the record to show to what extent it inhibits.

Mr. Lyon: I think the witness started to answer that the inhibited acid, as employed by Dowell, with these mercaptans in it, would last in these drums just about as long as this test 31 that you were just looking at, wouldn't it? A. Yes, and there is less than 1 per cent by volume of the material in there.

The Court: What is that?

Mr. Lyon: They have got just about as good an in-

hibitor as is represented by this test No. 31 with the arsenic or the pyridine, as I understand the witness' testimony.

The Court: I did not understand him to say that. I got the notion that it would not inhibit as good as that; if you put it into a drum, it would not stay in there without blowing up, as soon as this did.

Mr. Lyon: I know Your Honor has that idea, but the witness has testified to the contrary.

The Court: Is that right? A. Yes, it is my idea that it would come in this same range.

The Court: You have tested that, I suppose? A. No, sir, I have not tested that. I know that on my strip test, the data is comparable to this, and from that I have difficulty in making a prediction, but I would predict that a drum will blow up, from my strip test data.

Mr. Owen: I wish you would find the book about your strip test data, where you use the bases alone without metals and acids, and show the length of time, or the rate of corrosion, rather, if you can find that? A. Yes, I can find it.

Mr. Lyon: I want to make that clear, while I have the opportunity, that the plaintiff in operating uses an inhibitor which is around 99 per cent complete, and actually—

The Court (interposing): I think you are talking about their advertising, and they indicated that maybe that was too strong.

Mr. Lyon: I think they said that, but that they did it for tactical purposes, but factually I think that is true.

The Witness: Mr. Lyon, I am just merely indicating that if you have that low rate of corrosion which we get on strip tests, that I would predict the drums would have a long life. I haven't tested a comparable test.

Mr. Lyon: I understand, but you do know the rate of corrosion of the mercaptans employed by the plaintiff.

Mr. Owen: He is looking for that now. A. If you take these pyridine bases of Barrett, which I was talking about, going back into PX-344, one-half per cent of these pyridine bases of Barrett gives a corrosion rate in 20 Baume of 0.133 pounds per square foot per day.

Q. Which one are you referring to, which example? A. I am referring to that (indicating). Way at the bottom, 32?

Q. That has no metal in at all, has it? A. No, that is just the bases alone.

Q. In 20 degree hydrochloric acid?

Mr. Lyon: Are we getting off of the subject now? I thought he was looking up the corrosion rate of the mercaptans employed by the plaintiff. A. Oh, no, that has no bearing on this patent and I haven't got any of that test data here at all.

Mr. Lyon: You haven't got it here, but you do know the corrosion rate of the mercaptans employed by the plaintiff is way up in the same figure with these solutions using the amounts of arsenic and pyridine which is shown in this test 310, your latest exhibit? A. It is in that range, somewhere in that neighborhood, but I don't know the exact figures, and I don't know it by this particular concentration of acid; I am just using my imagination.

Mr. Owen: Now, this Barrett compound that you have been talking about, in what proportions is that used as an inhibitor? A. Well, it is used in less than 1 per cent.

Q. And what is the large use of it, the most extensive use of it? A. Well, it is used in pickling, that is the big use.

Q. Do you know how long it has been on the market? A. No, I cannot say that I know how long it has been on the market, but that type of material has been available for a long, long period of time.

Q. Do you know whether it is made in a manner somewhat similar to that set forth in example "A" of the Gravell patent? A. Well, it fits that description, that is, it is an organic base mixture, so it fits that description.

Q. Do you know what acid it has in it? A. Yes, usually the admixture that I was talking about that is shipped has sulphuric acid mixed with these pyridine bases, but this particular one I used here is just a pyridine base, it has no water or no acid added to that, that is a straight

pyridine base alone admixture; I mean just the pyridine base, no water and no acid, as you buy that on the market.

The Court: Let me ask you this; does part of the inhibiting force of this combination result from the fact that it has also destroyed it as acid to eat anything? Of course I could inhibit stuff if I didn't want to eat rock, I don't know, put in maple syrup, I guess, and reduce the amount it would eat the iron, but I didn't understand that is the true definition of an inhibitor. I thought it meant it left the acid just as active on the rock, for instance, as it was before, but inhibited it from eating the iron; isn't that the way it is? Now, I am just wondering here if a part of this inhibition resulted from simply putting in so much of it that you didn't have very much acid, comparatively? A. That is correct; if you start out with this 20 Baume hydrochloric acid, which we started out with, and add this volume of the pyridine bases, I have found that the acid is approximately 17 per cent concentration, and you neutralize your acid by means of your base just as usual; that is, you form a salt.

The Court: I don't think of that part of it as an inhibitor effect? A. No, that is, just as you said, weakening your acid, using up your acid otherwise.

The Court: Well, now, do I understand here of this, it we call it an inhibitor in here, that it is 75 per cent acid and 25 per cent this stuff? A. That is correct, that is the example "A."

The Court: I say that will explain some of the inhibition, I think? A. Oh, yes.

Mr. Owen: But when you put in 75 per cent of hydrochloric acid with 25 per cent of these pyridine bases, how much of the hydrochloric acid remains after the reaction? A. 17 per cent of the acid still remains.

Mr. Lyon: Wait a minute. I would like to have it cleared up, what he means by 17 per cent of the acid, instead of being 20 per cent it is 17. A. Well, let me draw you a picture.

(Witness drawing diagram on blackboard.)

A. If that is all of my acid at the start, let it be all

31.45 per cent acid. Now, you can imagine it this way: That when you put this organic base in there with that, that it takes about just half of that acid to take care of the organic base, just about half of it. It is 17 per cent instead of 15. If it was half it would be about 15.7. In other words, the organic bases use up the acid, and the mixture itself contains one-fourth of that organic base. I don't think of that as an inhibited acid. I think of that as a pickle inhibitor. That is what it is. That is the business that the American Chemical Paint Company was in, and that is the thing that they wanted to ship. They weren't shipping inhibited acid. They were shipping pickling inhibitor, as I understand their problem.

The Court: Part of it is inhibited, and part of it is diluted, isn't it? A. That—well, yes, I think I see what you mean by that statement.

The Court: Part of it is putting a coat on the wall. A. Well, let me do this. Let me continue to put this organic base in here. If I put more organic base in, after a while my mixture is alkaline. These agents take the—you see, you have got two points here. You have got the point—

The Court (interposing): With enough, you wouldn't have anything? A. If you put enough of that in it is alkaline.

The Court: You wouldn't have anything to eat the limestone rock? A. That is correct.

The Court: Yes. A. Now, the point I am making is that the usual practice in the use of inhibitors, as I find it in the art, as I have used it in our laboratory testing, is one per cent is high.

The Court: They can use it that way, but it seems that the arsenic in there, this one has an inhibiting effect, and at the same time every bit you put in, even if you put in one per cent of that, to that extent you reduce its strength, the strength of your acid, I suppose? A. Yes.

The Court: To that extent? A. That would be true.

The Court: Of course, you get around where you put in 25 per cent, and you have increased it proportionally, the

acid strength is, isn't that right? A. You have decreased it.

The Court: You have decreased the acid strength? A. That is right.

The Court: According to your solution.

Mr. Owen: Suppose you start out with 15 per cent hydrochloric acid in that example A of the patent, and put 75 per cent of that in with 25 per cent of these pyridine bases. How much acid would you have left, if you put it down an oil well? A. I could make a quick guess. The thing would be alkaline and it would be useless as a limestone solvent.

Mr. Lyon: May I ask a question, Your Honor? The plaintiff today has given us a list of the things it has added to its acid, and along with its inhibitors, and what about these Barrett materials, aren't they the very thing that you are talking about, these pyridine bases? A. They are similar.

Mr. Lyon: I mean, the plaintiff itself is using these very things we are talking about, or has used them. A. That is correct, but we don't use them with arsenic.

The Court: You are asking a question and you haven't answered it. A. We don't use them with the arsenic.

The Court: It isn't in the record.

Mr. Owen: We don't use 25 per cent.

The Court: As I understand it, you asked me, or somebody here, what per cent the plaintiff is using, and my answer is that if it is addressed to me, you haven't proven it. What per cent of that? You tell us that you put it in, but you don't say how much.

Mr. Owen: You mean we haven't proved how much our acid is inhibited?

The Court: What per cent?

Mr. Owen: I didn't understand.

The Court: I say, the question came up about something that is in yours, and I understood Mr. Wiles to say how much of that do we put in, and I say well, you haven't proven it in the record. The record doesn't show it. And I think that is right.

Mr. Owen: We will be glad to have Your Honor have that information. I didn't think that that was a part of our case and necessary to prove.

The Court: Well, it just came up here. Isn't that the question you asked, Mr. Wiles?

Mr. Owen: Well, I think I am safe in saying that we don't use more than around one per cent. It is down in the low figures. I don't know.

Mr. Wiles: That is the point.

Mr. Owen: Yes. A. And we don't use arsenic with it, or tin or any other metal.

Mr. Wiles: When we use it we use it alone.

Mr. Owen: What we do, when we buy these commercial bases they are manufactured by different companies, aren't they? A. That is right.

Q. And sold under different names? A. Special products.

Q. And shipped out in steel cans or steel containers? A. That is right.

Q. Drums? A. That is right.

Mr. Owen: We buy them and we put them in our 15 per cent commercial acid, somewhere around one per cent of these commercial inhibitors.

The Court: How long have those things been on the market? A. Well, I don't know. I can find out. But I think a number of years they were on the market. They are on the order of this Rodine mixture that the—

The Court: How long—they are inhibitors, aren't they? A. They are inhibitors.

The Court: How long have inhibitors, as such, been a commercial article that they have sold? I know they have known for a long while about them, the chemists have.

Mr. Owen: I am sure they were sold to the pickling industry long before the Gravell patent in suit. Gravell's company was selling—

The Court (interrupting): The same kind that you speak about that you are buying?

Mr. Owen: Substantially so.

Mr. Wiles: Your Honor, we can say at least Mr. Douty testified that they were selling Rodine without any arsenic in it as early as 1923.

Mr. Owen: That is right.

Mr. Wiles: So we know that has been on the market that long. I don't think they were the pioneers.

The Witness: The curve C-1830 summarizes the tests I made on ten gallon drums containing 20° Baume hydrochloric acid solution and a metal or a metal and an acid regulator.

hours. Minimum failure time was 21 hours and maximum failure time was 55.

Mr. Owen: What were the minimum and maximum pressures on that? A. The minimum and maximum pressures seem to be between 30 pounds and 50 pounds. You can't arrange them in order according to pressure and according to time.

The Court: No. A. The time is the thing I was considering more specially. So that the pressure element, 50 pounds is on test 10-72 and 30 pounds is on test 10-36.

Mr. Owen: Now, what does the data on this sheet show in comparison with these blanks? A. Well, it shows that some of these metals have a shorter life. The metal on test 10-50 was nickel, and we had a time of 20¾ hours, maximum pressure 56 pounds and it leaked in the bottom seam.

Q. Both of those failed quicker than the shortest failure of the blanks, is that right? A. Well, if you are talking of the average blank time.

Q. No, I am talking about the shortest blank time which was 21¾ hours and the tests of the same acid plus nickel failed in a shorter time than that. No, I am sorry—one was 22.1— A. That's right. You can say that for one but not the other.

Q. And the maximum pressure on these tests with the nickel exceeded that of any of the tests with the blank acid? A. That is true. The pressures were higher in those two tests.

Q. How about the next test with copper? A. Next tests 10-29 and 10-30 both were .15% copper. One lasted 23.9 hours and the bottom blew out. Now, when I say "blew out" I mean the ends of the drum. It may be one end or it may be the other, in some cases, depending on where the point of failure is. In cases where I offered photographs it is obvious the bottom blew out; in other cases not quite so obvious. I don't intend to distinguish between which end of it blew out.

Q. It depends on how the drum is standing in your test I suppose? A. That is true, too. These two tests on 10-29 and 10-30, both with 0.145 per cent copper, one lasted 23.9 hours, the other lasted 30.75 hours. The maximum pressure on one was 35 pounds, the maximum pressure on the second one was 32, that is 10-30.

Q. Now, Doctor, I would pass those two nickel tests following because we have already had nickel, and go down to the one numbered 7 with the arsenic? A. No. 7, 10-104, we had 0.102 per cent arsenic with 0.053 per cent pyridine base mixture, Interlake Iron Corporation, and the container lasted 233.5 hours, the maximum pressure was 17.5 pounds, and it leaked in the bottom seam. And, 10-03 was a duplicate test, as far as the amounts of arsenic and pyridine base are concerned, and it lasted 285.8 hours, the maximum pressure was 14.5 pounds, and it leaked in the bottom.

Q. Now, compare those with the next set of tests numbered 8 in which arsenic alone without any pyridine base was used. A. All right.

The Court: I am still back a little. 8 is the same thing with arsenic, compared with the hydrochloric. Yes, hydrochloric. The same experiment without arsenic.

Mr. Owen: Well, in the other table, test No. 31 had 1.32 arsenic oxide and 25 per cent by volume—that isn't a comparative test, because it has so much of the base. I will take the next test before that. 32 had .26 arsenic and .0057 gelatine distillate, and it failed at 563 hours. And the next test had .3 arsenic and the same amount of gelatine distillate and it failed in 667 hours.

The Court: All right.

Mr. Owen: Now, Doctor, compare these tests numbered 7 and those numbered 8 on this table with phosphoric acid and point out the difference in results of the test No. 7, being a mixture of arsenic and pyridine bases, and test No. 8 having only the arsenic? A. On test 10-52 0.19 per cent arsenic was used. 10-51, 0.19 per cent arsenic was used. 10-52 lasted 948 hours and 10-51 lasted 639.8 hours.

Q. In both of those only the arsenic was used? A. That is correct. The comparison there is arsenic with organic base against arsenic without the organic base.

Mr. Lyon: Did you point out that in the test with the arsenic with the organic base you had only about half as much arsenic as you did in the other test? A. The figures are here and I have stated the figures.

Mr. Lyon: You did not point that feature out? A. I hadn't gotten to that point, Mr. Lyon.

The Court: Can't do it all at once? A. It is all there.

Mr. Lyon: No.

The Court: Because there are so many things in here you can't—

Mr. Lyon (interposing): Well, I thought the witness had concluded and said that was a comparative test with and without the organic base. Of course, I wanted him to point out that in the one test there was almost twice as much arsenic as the other.

The Court: That is right.

A. And on these we had a leak at the bottom seam on one, and in the other the bottom blew out. The pressure on one was 9 pounds and the pressure on the other was 14½ pounds.

(The witness then explained his tests with two types of 55-gallon drums, one known as ICC 5E, being a light weight nonreturnable drum weighing around 55 pounds, and the other being known as ICC 5A drum, made of standard 18 gauge metal and weighing about 110 pounds. The results of these tests are shown in a table appearing on page 158 of PX-356 entitled "Failure Time of ICC 5E and

ICC 5A 55-Gallon Drums containing Hydrochloric Acid Solution With or Without a Metal or an Acid Regulator.")

Mr. Owen: Doctor, have you made any tests with a view to determining the loss of strength of 15 per cent hydrochloric acid during extended periods of contact with the inside of a piece of oil well tubing? A. No, I have not made any tests with oil well tubing, but I have made tests on pipe.

Q. Will you explain what tests you have made, and what pipe you tested? A. I just took the ordinary kind of pipe that we use in the plant. I have here a blueprint of the type of apparatus that we used. We had a bath here that we could control the temperature by. This data consists of two tables, four graphs and a blueprint showing the apparatus used. These are clipped together and offered as PX-357.

(Whereupon the documents above referred to were marked PX-357 by the reporter.)

(Witness): First I wish to describe the pipe that we have here. The test section where we tested the acid solution was a 2" diameter so-called extra heavy steel pipe, 20" long, of welded construction. That is, it was welded on the top and on the bottom, regular, extra heavy pipe. Then that was fitted by lines to a trap and back to a nitrogen cylinder so it could be put under pressure if we wished to run the test under pressure. I will start in on page 2 of the tables, test No. 1. The time of the test was $21\frac{3}{4}$ hours, temperature maintained was 43°—maximum was 48, minimum 40; the pressure was 1000 pounds. The 1000 pound pressure was put on the acid by means of nitrogen gas, so that the acid was under that amount of pressure under test.

The Court: Now, you have turned to the second sheet? A. Yes, I have turned to the second sheet. Maximum pressure at any time during the test was 1080, minimum 980. The analysis of the solution after the test (it was 15% before the test) was 0.014% hydrochloric acid, and the per cent iron was 10.62; the sample was taken at the end of the

time. Right next to that we have a test which run for 24 hours.

The Court: Now, that says percentage of iron. That means percentage of the mass of iron? A. That is the percentage of iron in the acid solution at the end of the test. The 15% acid, as you can see from the first figure there is used up so that all of the acid is practically gone.

The Court: The rest of it is water? A. That is right. Practically a solution of iron chloride when we get through with the test.

The Court: The water— A. With a salt.

The Court: Iron chloride? A. That is right.

The Court: In solution? A. That is right. Now, the graph that shows that data there has simply, of course, got our two points; we started with 15 per cent acid and at the end we had one hundredth of a per cent acid, and the iron was approaching zero at the start, and at the end it is about 10 per cent, so that shows the way the phenomenon goes, the acid getting weaker and the solution of iron salt keeps getting stronger.

The Court: And the place where it is getting the iron is getting lighter, the thing it is taking the iron off of is getting lighter? A. That is correct.

The Court: Thinner? A. That is correct.

Mr. Lyon: May I ask a question? Referring to the blue-print you just had, how big was the pipe? A. The pipe was a 2-inch diameter pipe, 20 inches long.

Mr. Lyon: How big a hole did it have in the 2-inch, is that inside? A. This is the inside diameter; no, we made these smaller here when we made these connections.

Mr. Lyon: What I mean is this, is the 2-inches outside pipe or 2 inches inside pipe? A. The custom on that, that is the way it is designated; I believe that is the inside diameter of the pipe.

Mr. Lyon: Just give me this data in here, how much acid did the pipe hold? A. (Referring to paper): I am getting to that; in test No. 1 I put in 581 c.c.'s of 15 per cent hydrochloric acid.

Mr. Lyon: And that same acid stayed in there for 21¾ hours? A. That is what the table states? That is what we did.

Mr. Lyon: Well, will you just tell me how much you put in on each of the tests and how long you stayed there, the same acid? A. We put in fresh lots of acid on each test.

Mr. Lyon: The same amount? A. And the amount was the same.

Mr. Lyon: 581 c.c.'s of 15 per cent hydrochloric acid? A. That is correct.

Mr. Lyon: And that acid stayed in there, that same acid remained for the full time indicated for the tests? A. For each of the tests, that is right.

Mr. Owen: Now, have you explained that some of these tests were made at atmospheric pressure and others under high pressure? A. I had merely described one test that was made under pressure and hadn't got to my description of the test without pressure.

Q. Well, you go ahead and explain the others, will you, please? A. Now, the next test was made at atmospheric pressure, the temperature range on that was from 40 to 46, and we tried to maintain a temperature of 43.

Q. What would that be in Fahrenheit? A. About 110 is what I calculate that at. Now, that one went down to 0.012 per cent acid and the iron went up to 10.29. Now, it was possible on that test to take out small samples for analysis, which we did, to give some picture of how the acid behaved over the time period. It is not as convenient to do that and keep your test at 1000 pounds pressure, so we started out with the 15 per cent acid and at the end of about three hours the acid was down to about 11 per cent. The iron was up to 3 per cent. At the end of 6 hours the acid was a little over 8 per cent and the iron was up to 4 per cent. At 9 hours the acid was down to 7 per cent and the iron was up to 5½. At 12 hours the value on the acid was about 5 per cent and the value on the iron was about 7 per cent, and you can follow along on the curve and see how

that change goes until we reach the end point at the end of 24 hours.

Now, test No. 8 was running under a 1000 pound pressure, and instead of running at 43 degrees we ran down to 30 degrees. Now, 30 degrees would be about 85 degrees Fahrenheit. The graph is labeled test No. 8, Your Honor, and it is the second one from the blue-print.

The Court: Oh, yes. A. Then on test No. 8, we ran that for 24 hours. We tried to maintain a pressure of 1000 pounds. The maximum was 1060 and the minimum was 960. The hydrochloric acid went down to 4.6 per cent and iron went up to 7.04.

Then we ran a similar test at the same temperature, which was about 85 degrees for 24 hours, and the acid came from 15 per cent down to 6 per cent and the iron went up to about 6 per cent, and the data that I have just described in the table is graphically presented in the curves on test No. 8 and the test on No. 7, going to a little more detail on No. 7. I would like to discuss the curve on test No. 7. At 3 hours the iron was up to 1½ per cent.

Mr. Owen: That was atmospheric pressure? A. That was atmospheric pressure. And at 86 degrees—I calculated 85—and the acid was down under 14 per cent, 13.6. At the end of 6 hours the iron was up to 2 per cent and the acid was down to 12.5. And at 9 hours the iron was up to a little below 3, to about 2.8, and the acid was down to about 11½. And we will go over to the end point. At the end of 24 hours, both of them come together there at about 6½.

The Court: As you kept on across, the iron goes— A. (interposing): In time, yes, sir.

The Court: The iron would go up probably and then— A. (interposing): The acid would keep coming down.

The Court: The acid down? A. That is correct.

The Court: And it was just a coincidence that they met at the end of the day? A. That is true. You wouldn't know what was going to happen.

The Court: Somebody might get the notion that was a day's work, to bring them together.

Mr. Owen: Well, now, Doctor, look over your letter to me and be sure that you have stated in your testimony all of the points you wish to make of record? A. I should make clear one point which I have not, that this amount of acid that I put in the pipe, the 581 c.c. were calculated to fill a foot length of that pipe so that I had 8 inches of space, theoretically, above that. I can't say it was exactly a foot.

Mr. Lyon: The acid always stayed in that same foot? A. That is correct, yes, sir.

Mr. Lyon: It filled the bottom part of the pipe with acid? A. That is correct.

Mr. Lyon: And left it there for that twenty-four hours? A. That is correct.

Mr. Lyon: Or whatever period of time? A. That is right, sir.

The Court: It is just like a little tank half full? A. Yes. I was asked to make the test on the pipe and fix it up and run it under pressure, which I tried to do.

Mr. Owen: I find that I neglected to offer copies of the patents and publications which were referred to by Mr. Rebbeck, and I would like to supplement Plaintiff's Exhibit PX-338 by adding such references as were referred to by Mr. Rebbeck, but not included in that exhibit.

Mr. Lyon: In other words, you are going to add some more to that book, and they will be the ones that Mr. Rebbeck referred to, but which are not already in the book.

Mr. Owen: That is right.

Mr. Allen Owen: We are going to dispose of some of the matters that have been held in abeyance, without calling witnesses for them. First, we have corrected PX-232, having gone over it with Mr. Lyon, and that is a complementing sheet for PX-10, which shows the number of treatments performed by Dowell, Incorporated, and we have limited the treatments to exclude all of those which were made in California, because the California treatments did not involve the treatment of limestone formation. In addition, we have eliminated the so-called mud acid treatments, for much the same reason. We have eliminated the treatments of Dow Chemical Company, because they were not performed by Dowell. We have eliminated truck rentals, that is, instances in which Dowell did not perform the treatments themselves, but in which they rented their equipment for the performance of the treatment. We have eliminated these stuck drill pipe treatments, because that would not come under the Grebe and Sanford patent. We have also eliminated the packer seal treatments, which were of somewhat different type, and also scale removal treatments, and the elimination of the California treatments takes out most of the scale removal treatments. On checking back over the records for the past three years, Mr. Pennhaligan was able to find only six scale removal treatments which were performed in the year 1940, and he was unable to find the records, and, therefore, unable to estimate, as I understand it, the number of scale removal treatments performed during 1932 to 1937, in those intervening years. The number was quite small and would not substantially affect the total of the well treatments reported on this sheet.

Mr. Lyon: Will this have the same number, 232, corrected, Your Honor, or should it have another number?

The Court: You will call it 232 corrected, and I will give it number PX-347.

Mr. Allen Owen: In addition we had an exhibit which was formerly PX-233, which shows the number of treatments made by licensees of the Dow Chemical Company, other than Dowell. Now, we have corrected that report to eliminate the California licensees and thereby eliminate the treatments which related to stuck drill pipes, treatments of that character.

(Plaintiff's Exhibit 232 corrected was thereupon marked PX-347.)

(Plaintiff's Exhibit 233 corrected was thereupon marked PX-348.)

Mr. Allen Owen: This sheet shows during the years 1934 to 1940, inclusive, licensees other than Dowell performed 2,277 treatments. Then during the examination of Mr. Pennhaligan, Mr. Lyon requested a summary of the activities of the licensees of the Dow Chemical Company showing as well as we could the volume of the business which they have done under their licenses, and Mr. Pennhaligan has prepared a schedule which I shall request be marked PX-349.

(The schedule referred to was thereupon marked PX-349.)

Mr. Allen Owen: This shows that business, which doesn't reflect any income from the California licensees, but does show an income to the Dow Chemical Company, total income for 1936, '37, '38, '39 and '40 of $107,768.73 from its licensees.

Mr. Lyon: In connection with PX-349, we are to understand that any other licensees who were mentioned in Mr. Campbell's testimony, whose names do not show any payment on PX-349, haven't paid any royalties, is that right?

Mr. Allen Owen: I don't know exactly which licensees you refer to.

Mr. Lyon: I haven't had a chance to mention them, but if there are other licensees referred to in Mr. Campbell's testimony, whose names do not appear on this PX-349, why, you haven't received any royalties from these others?

Mr. Allen Owen: I don't think I can agree with that unless I am absolutely sure; I will find out and I will know this afternoon what the fact is on that.

Mr. Lyon: All right.

Mr. Allen Owen: Then in order to show the continuity of use of inhibiting agents and surface tension reducing agents in the activities of Dowell, Incorporated, Mr. Pennhaligan has prepared from the books of Dowell, Incorporated, a schedule showing the number of gallons of inhibited acid used by that company in all of its work, as well as the number of gallons of inhibitor which were shipped to the various Dowell stations, and the number of gallons of surface tension reducing agent which were shipped to various Dowell stations, tabulated by years. I would like that table to be marked PX-350.

(The table above referred to was thereupon marked Plaintiff's Exhibit No. 350.)

Mr. Allen Owen: That is a schedule showing the number of gallons of acid used by Dowell, and the number of gallons of inhibitor and surface tension reducing agent which were shipped to the field. This is the testimony that Mr. Pennhaligan would give were he recalled. He compiled these tables.

The Court: That does not include what that is?

Mr. Allen Owen: No, sir. I am looking for that data now. I intend to read that into the record next.

Mr. Wilber Owen: Another matter, counsel have agreed to clean up by stipulation, you will recall that we requested defendant to produce the acidizing order and data sheets for the some 100 odd well treatments made by the defendant in Michigan; the acidizing tickets for those treatments are in evidence, but in addition to the acidizing tickets in each case there is an acidizing order and data

sheet filled out, and that order and data sheet contains information regarding the well structure, that is, the depth of the formation and the length of the casing and tubing, and so forth, that is not contained on the acidizing tickets.

Now, in lieu of the presence of those acidizing orders and data sheets, for all of those 100 and some odd treatments, counsel have agreed that the data appearing on the acidizing orders and data sheets for the Stella Wilcox, the Zahn and Crawford and the Knight wells shall be taken as typical of the conditions which existed in the other—in connection with the other treatments, and I, therefore, offer as PX-351, a set of these four acidizing orders and data sheets, and also of the acidizing tickets, although this is a duplication so far as the acidizing tickets are concerned, of a previous exhibit, but I thought it would be better to have them in one exhibit, so I am offering those. They cover five treatments. Two Stella Wilcox treatments, Your Honor. And as long as they were all referred to in the testimony, I thought it would be better to include the order sheets and the acidizing tickets for each treatment, although it covers only four wells.

The Court: Acidizing orders and data sheets for four of defendant's wells, stipulated to be typical.

Mr. Owen: That is right, Your Honor.

The Court: That is all wells acidized in Michigan?

Mr. Owen: Well, it is all that were acidized in Michigan up to the time the depositions of Mr. Edwards, the Halliburton manager at Mount Pleasant, and some of the employees there were taken in June of 1939. And that, I understand, includes all of the treatments made up to that time, in the eastern district of Michigan. That is in this district only.

Mr. Allen Owen: To continue with my offers; the defendant wanted to know what inhibitors we had used commercially, and we have that information, and in some instances the material is named by the manufacturer, and therefore its exact composition is not known to us. This will be PX-352.

Mr. Lyon: These were those that were employed by Dowell before the filing of this counter-claim, is that correct?

Mr. Allen Owen: Oh, yes, both before and after.

Now, Your Honor has requested earlier information concerning the advertising by Dow and by Dowell Incorporated, and I have a schedule prepared by Mr. Pennhaligan from the books of the company, to which he would testify were he requested, which I shall request be marked PX-354.

(The schedule referred to was thereupon marked PX-354.)

Mr. Allen Owen: In connection with PX-350, we have prepared a chart showing the relationship between the gallons of inhibited acid, and the gallons of inhibitor, and the gallons of surface tension reducing agent, and have simply plotted these numbers on the chart in an effort to show that as one business—or as the volume of one item increases, so does the volume of the rest. I have reductions of that chart which I would like to have marked PX-350-A in order that it may go along with the table from which the chart is prepared.

(Photostatic reduction of the chart referred to was thereupon marked PX-350-A.)

The Court: Now, what about the men that are out, do you have solicitors soliciting business? Did they have during that period?

Mr. Allen Owen: If you will excuse me just a moment, I think I can get the answer to that question.

The Court: During these years we have the advertising expense.

Mr. Allen Owen (after conferring with Mr. Crawford): I am informed, Your Honor, that during the year 1932, there was no particular effort made to do anything more than to train men; and during the year 1933 very little salesmanship was employed, but most of the salesmen went around to service inquiries which came in, and it was not until 1934 that any active salesmanship was engaged in, because in that year competition appeared, and it became necessary then to sell the services of Dowell, Inc.

The Court: How many salesmen did they have in that year?

Mr. Allen Owen: We have a chart, Your Honor, which is in evidence, which shows the personnel and growth of Dowell, Incorporated.

The Court: Does that divide them into the different classes of employees?

Mr. Owen: No, it does not.

The Court: That is, as to how many were doing the work of acidizing, how many were in the offices, and as to how many were in the selling department?

Mr. Allen Owen: That is right it does not, Your Honor. I think the total personnel of Dowell, Inc., for the year 1933, for example, was 33 persons. There were six treating stations in operation. There were eleven pump trucks. There was one truck transport, and one tank trailer, or, three tank trailers, I beg your pardon. This appears on PX-94, and you will notice from that exhibit that the personnel—

The Court: What was it in 1934, the personnel?

Mr. Allen Owen: It grew to 60 that year. They opened four new treating stations, and bought five new trucks during that year, so that the growth in the field nearly doubled the number of wells treated in that year over the year before, and the personnel also was about doubled.

Mr. Wilber Owen: Counsel have agreed that in lieu of calling witnesses to show the brine well treatments made by the Dow during 1930 and 1931, somewhere along in there, that we may stipulate that if Ira Nolan Poffenberger were called as a witness he would testify the same as he did when his deposition was taken by defendant at Midland, at the hearing of July 24th to August 2nd, 1940.

The Court: That is relative to what?

Mr. Owen: Brine well treatments by Dow, and in Mr. Poffenberger's deposition he referred to a report he made to Dr. Grebe on September 26, 1930, regarding the acid treatment of well No. 77, and that report will be offered here as PX-362.

Mr. Owen: Mr. Penhaligen has prepared a statement of Dowell's advertising expenditures subsequent to 1934, which I offer in evidence as PX-360. This brings the advertising down through 1940, and at the same time shows the number of paid treatments using the Grebe and Sanford method. (Tr. p. 6663.)

IRA NOLAN POFFENBERGER

testified by deposition (offered by plaintiff) as follows:

DIRECT EXAMINATION

By Mr. Richmond:

I reside at 516 McDonald Street, Midland, and am a research chemist, chemical engineering, for The Dow Chemical Company.

I have a degree in chemical engineering from Case School of Applied Science, and a Ph.D. from Massachusetts Institute of Technology. My position with The Dow Chemical Company is research chemist in Mr. Putnam's department. That is the heavy organic department.

I am acquainted with John J. Grebe, and have known him since 1928. I first entered the employ of The Dow Chemical Company in 1928 as one of Mr. Grebe's assistants. I graduated as an engineer in 1928.

The first work I did in connection with the acidizing of brine wells was the latter part of 1929. The first well we used was an old well down behind our salt station, I believe well No. 3. Our first treatment was to run acid into the well through a short hose under gravity head from a wooden tank wagon—acid tank wagon. But the well wouldn't take a flow that way and so we used a little glass pump and pumped the acid from the wagon into the head of the well; at the same time we ran water along with it.

Mr. Richmond: How far did this hose extend into the well? To what depth, approximately? A. You mean—well, we used a pump. That didn't extend into the well at all.

Q. When you ran it under gravity. A. When we ran it under gravity it extended not more than 10 or 15 feet.

Q. Who was it that determined the apparatus and the method of treatment of this well No. 3? A. Grebe and I talked it over. He gave me free rein to do as I pleased, but everything I did was with his Okeh.

Q. Now, what strength of acid did you use? A. Oh, it was approximately 30%.

Q. And you put it directly into the top of the well and are you able to say what the degree of dilution was with the water introduced with it at the same time? A. I can't say it very accurately because the pump we used didn't work very satisfactorily.

Q. Then you aren't able to say what the acid was—whether it was a 10, 15, 5 or any other degree of strength? A. No. I am sure it wasn't over 15%.

Q. Now, what was the next well treated, Mr. Poffenberger, and when? A. It was around Christmas time. The next one, I believe, was No. 13, next to Grebe's house.

Q. What technique did you use on that well in treating it with acid? A. The same. We pumped into the head of the well.

Q. Along with water? A. Yes.

Q. You had one pump pumping water and the other pumping acid, is that correct? A. We used city water pressure for the water and the acid pump pumped only acid.

Q. And that pumped directly into the head of the well? A. Yes.

Q. Do you know a man by the name of Robert J. Quinlan? A. Yes, he worked for me.

Q. He worked along with you and did some of the manual work, is that correct? A. Yes, he didn't do much on that well I don't believe, but I am not sure. I don't believe he was working with us then.

Q. What other technique did you use in treating the brine wells with acid, mode of operation, method? A. You mean of any wells or just those two?

Q. No, any wells up to, we will say, 1930, '31, up to the time you quit treating brine wells with acid. A. Well, the first thing we did was to develop a pump that would pump acid for long periods of time without much attention. This was a two-cylinder pump with one piston. One piston was small and then it was in a large piston. The piston towards the stuffing box pumped water and the small piston

pumped acid. That protected our stuffing box so our pump worked satisfactorily. When we got that pump, we pumped all of our acid down through a hose that reached to the bottom of the well.

Q. And how long was this hose in most instances? Or how deep were the wells, we will put it that way, that you were treating? A. The deepest one was about 1400 feet.

Q. And you used a rubber hose 1400 feet long? A. Garden hose.

Q. How was that garden hose—was it strong enough to support itself? A. No.

Q. How did you support it? A. You can't get it long enough, either.

Q. Well, you can screw joints together, can you not? A. No, we used bakelite connectors that we stuck inside the hose and then put regular clamps on the outside, regular screw hose clamps on the outside that connected our links together. The hose itself was supported on a wire cable. The cable was run—we had a power winch that handled the cable and a reel that handled the hose, and we would start them both down together and at intervals of 10 to 15 feet we would spread the wires in the cable and use a copper wire to tie the hose to it, and then we would tape it.

Q. At intervals of 10 or 15 feet? A. 10 or 15 feet. That was about how close it was.

Q. How long did it take you to run this garden hose into a depth of say 1400 feet? A. It would take us two days.

Q. In making connections and all? A. Yes.

Q. And how long to remove this rubber hose from the well? A. Well, that wasn't nearly so long. Four hours.

Q. Now, did you use any other technique during the treatment of brine wells, either for increasing the flow of brine or for the purpose of disposal of brine in those wells? A. After we had that equipment, we used it on every well.

Q. And the technique that you have described is the only technique that you used in the treatment of brine wells

while the same were being treated by The Dow Chemical Company, is that correct? A. Except those first crude experiments that I have described. Those two techniques were the only ones employed.

Q. Do you know of anyone else doing work on brine wells for The Dow Chemical Company during the time that you have been with The Dow Chemical Company other than that work that you have described? A. No one did any acid treating other than me.

Q. Did you ever on these brine wells prior to February, 1932, use an inhibited hydrochloric acid in the treatment of brine wells, either for increasing the flow or for the purpose of disposing of spent brine? A. No.

Q. Did you do any work on inhibitors for hydrochloric acid during the year 1932? A. I wasn't here in '32. I left the Dow Company in September, 1931, to go to M. I. T.

Q. When did you return, Mr. Poffenberger? A. In 1934.

Q. Do you know when the last work was done in the treatment of brine wells by The Dow Chemical Company on any of their wells for any purpose? I mean by "treatment" treatment with acid. A. You mean the last work done up until the time I left, or since then?

Q. Up to the time you left in '32. A. '31. All that work was done by me. The last work was on wells 77 and 80.

Mr. Richmond: May we have the original records on 77 and 80.

Q. State if you know, whether there was any acid treatment of brine wells after you left in September, 1931? A. I can't answer that. I lost all contact with it.

Q. I will ask you this—at the time you left in September of 1931 were acid treatments of brine wells still continuing? A. No.

Q. And how long before you left in September of 1931 had the acid treatment of brine wells been discontinued by The Dow Chemical Company, approximately? I don't expect you to be able to say to the day or the week, or perhaps

the month, but approximately. A. Maybe I didn't answer that question before exactly right. Maybe Quinlan at the time I left still had some well work in progress. It is all close together in there and I just can't tell you.

Q. Well, when was the last work that you did on acidizing of brine wells before you left in September of 1931? A. You see you have me confused in dates. Maybe it's the year before.

Q. Well, I don't want to confuse you. A. If I remember correctly, wells 77 and 80 were treated in 1930 and that work was completed that winter. That was the fall I was guessing about Quinlan. The next summer we didn't do any acidizing work. We were working on brine disposal and we had drilled what we called our Parma well across the river for disposal of brine, and I was working there. So I believe that this acid brine treating had all been completed by the time I left in 1931.

Q. To your knowledge has there been any acid treatment of brine wells by The Dow Chemical Company since the last work which you mentioned in your last answer about wells 77 and 80? A. I believe not.

Q. Now, did you before you left The Dow Chemical Company in September of 1931, have anything to do with the treatment of any oil well with acid? A. No.

Q. In your duties with The Dow Chemical Company has the drilling, conditioning or maintenance of brine wells come under your department, under your supervision now? A. No, I have had nothing to do with wells since 1931.

CROSS EXAMINATION

By Mr. Owen:

Q. You stated that the first brine well you treated was the No. 3 well. Was that a producing well at the time you made these treatments? A. No, it was a discarded well.

Q. Do you know how long it had been discarded? A. I can't say exactly but I believe it was at least five years.

Q. What was the object sought in treating that well?

A. Our object in all of our first work was to dissolve out enough of a cavity so that a well could be used for the disposal of brine.

Q. Where did this brine come from that you wanted to dispose of? A. Waste brine from the plant.

Q. Do you have that waste brine in large quantities? A. Tremendous quantities.

Q. How was it disposed of prior to the time you began to treat these oil wells? A. For many years they put it into the river as they made it, as it was pumped through the plant. But it became a waterway nuisance so the question arose as to whether we could pump it back into the well or whether we would have to build these large impounding ponds. At that time those ponds were being built. This brine is stored—I believe it is stored sometimes as high as two years, until they have high water in the spring and then they put it in the river in regulated quantities.

Q. And is that the way the waste brine is disposed of now? A. Yes.

Q. Was the treatment of that No. 3 well successful in the disposal of waste brine? A. No, it wasn't very successful.

Q. Why not? A. That particular well didn't take brine very readily.

Q. What was the condition of the casing in that well? A. I believe that well had been plugged at the bottom but it had a hole in the casing.

Q. Do you know where that hole was located? A. I can't say now definitely. We had a means of determining it and I believe it was in the Parma formation.

Q. From what formation do you get the brine which is pumped for use in the Dow plant? A. I believe it is called the Marshall.

Q. Where is the Parma formation located with reference to the Marshall? A. It is above, at about 600 feet level here in Michigan.

Q. And the Marshall level is about what? A. Oh, 900 to 1200 in this region.

Q. I understood you to say some of these wells were 1400 feet deep. A. It goes deeper as one goes towards Mt. Pleasant. I believe 77 and 80 were 1400 feet.

Q. What is the character of that formation? That is, the Marshall formation. A. It is essentially sandstone.

Q. And what was the object of treating sandstone with hydrochloric acid? A. We hoped that there was enough limestone in it that when the limestone was dissolved out the sandstone would be made more porous.

Q. When you discontinued your work on the No. 3 well (that is, the first work) did you do any more work on that well towards the disposal of brine? A. No.

Q. Then you next tried the No. 13 well I believe you stated? A. Yes.

Q. Did you meet with any better success in that well than you did No. 3? A. The answer is the same—it wasn't successful. After we ran this well a short while it took tremendous quantities of water. We were connected with the city water line and it took tremendous quantities of water. At that time the well was standing with its pump rod in it. This well was a well whose derrick had burned down some time that fall. The well was abandoned by the Dow company.

Q. It had been abandoned before these treatments? A. Yes, the derrick had burned down and we used this old well for that purpose. When we found it was taking these large quantities of water, we felt there was a leak in the casing, not in one of the rock formations. Later we pulled the pump rods with a portable rig and dropped our conductivity electrode and found that there was a definite break in the casing of this well.

Q. How far above the bottom of the well, if you recall? A. I think, if I remember correctly, the break was around 300 feet, which is just about the bottom of the glacial rift on this elevation in this vicinity.

Q. And what did you conclude as to the point at which this large quantity of water which the well was taking was escaping from the well casing? A. It was escaping at this

higher level which was higher than we could allow for the disposal of brine.

Q. So that the acid was not reaching the Marshall formation which you wished to reach? A. No.

Q. Did you then discontinue your treatments of the No. 13 well? A. Yes.

Q. And did you thereafter treat any other wells for brine disposal? A. The only well that we treated for brine disposal and made a very thorough study of was No. 4, which was in the bromine plant out here. It was also an abandoned well. It had been closed at the top. It was under a concrete floor when we started the work. We broke the floor and put a new head on the well. The reason we picked this well, after we found out it would work, was mainly because it was accessible enough that we could pump brine to this well. We pumped brine into this well for a period of several months.

Q. Was it then abandoned for that purpose? A. Yes; it was abandoned when we obtained—it was just an experimental well and we abandoned it when we proved to our satisfaction brine could be disposed of down a well.

Q. You spoke of treating wells Nos. 77 and 80 for the purpose of attempting to increase the brine production from those wells? A. Yes.

Q. Did those treatments follow the brine disposal experiments which you have referred to? A. Yes, because we only had one winch and cable and hose setup.

Q. Were wells numbers 77 and 80 producing wells? A. Yes, they were very poor producers.

Q. Which of those wells did you treat first? A. No. 80.

Q. Can you state approximately the dilution of the hydrochloric acid which you used in the well No. 80? I mean the acid that was put into the well and down to the Marshall formation. A. The acid was taken to the well as 30% acid. It was put down with our two-compartment pump which pumped it down the hose at approximately 15% acid. We ran some brine back into the well, using the

pump pressure from other wells to do it, but what that quantity was I can't say definitely; the dilution of the acid at the limestone I couldn't say.

Q. How did the quantity of brine pumped into well No. 80 compare, roughly, with the quantity of 15% hydrochloric acid which you pumped into that well? A. Well, I can't answer that exactly. The answer to that is what I said before.

Q. Was well No. 80 drilled into the Marshall formation? A. Yes.

Q. And that was the same sandstone formation which you have previously referred to? A. Yes, so far as we know.

Q. Do you know of your own knowledge what effect the treatment of well 80 had on the brine production from that well? A. The well was originally what we call an 80-second well. It requires 80 seconds to fill the pail that they use in the wells. It is about a 3-gallon pail, roughly. After the treatment, the well became about a 60-second well, which is some improvement, but a good producing well in the Dow company's field runs around 20 seconds—20 to 30 seconds.

Q. Your treatments of well No. 77 followed that of well No. 80? A. Yes.

Q. And how did your treatments of well No. 77 compare with those of the No. 80 well? A. The results were similar. There was a slight improvement but not enough to make a good producing well out of it.

Mr. Richmond: At this time I ask that you produce the reports on wells 77 and 80.

Mr. Owen: We will produce those reports.

Mr. Richmond: I want to examine the witness on them. I want the original report.

Mr. Owen: Copies of these reports were furnished to defendant's counsel several days ago.

Mr. Richmond: I have received photostatic copies of problem No. 0109 together with the letter from Grebe to Griswold, dated June 6, 1932.

REDIRECT EXAMINATION

By Mr. Richmond:

Q. I show you Volume 8 of Physical Research Laboratory reports, and especially the problem No. 0109 by N. Poffenberger appearing in the upper right-hand corner of the first page. I call your attention to the three pages of the report accompanied by three pages of tabulation, and ask you if you made that report (handing same to witness). A. Yes.

Q. And that report was made to whom? A. To John Grebe.

(This report was offered as PX-362.)

Q. I call your attention to Volume 7 of Physical Research Laboratory reports and call your attention to file No. 0075, sometimes known as problem number, and particularly direct your attention to the two pages of the report made by you. That was made by you, was it? A. Yes, sir.

Q. On the date stated of 8-18-30? A. Yes, sir.

Q. And that report was on what well? A. 80.

Q. Brine well 80 of The Dow Chemical Company? A. Yes.

Q. I call your attention also to two additional pages one which has a curve, and the second additional page is a table. A. Yes.

(The report was offered as PX-363.)

Mr. Owen: Then it has been agreed that we may offer another report of Mr. Poffenberger's to Mr. Grebe, which was not referred to in the Poffenberger deposition, but which was referred to during other depositions taken at the same time. That report is dated 7/21/1930.

(The report referred to was thereupon marked PX-364.)

Mr. Owen: Now, PX-363 is short and I will read from it to give Your Honor an idea of the work. This report, I should have stated, related to acid treatment at well 80, the other report was at well 77. This states:

"**Results:**

"Acid and water or brine was pumped down the well to attack any limestone formation that might be present. Experiment was carried on from July 7th to Aug. 15. In the time 22,000 pounds of 30 per cent HCl solution was pumped down the well.

"At the start of the experiment the brine level in well was 108 feet from the top. At the end of the time it was 20 feet, the difference being due to the difference of the densities of brine and water.

"Water was pumped down well for one week during the time the rate fell from 0.4 gal. per minute to 0.1 gal. per minute.

"The rest of the time brine was used to keep the acid going down the well. The well took brine at a rate of 0.5 to 0.3 gal. per min.

"**Description of Work:**

"The brine level in well was measured by conductivity cell on end of wire and was 108 feet from top of well. This made a head of only 108 times 1 divided by 2.3 times 1.25 equalled 38 pounds pressure for putting down brine or 30 pounds pressure for putting down water. On August 16 when the work was stopped the level was 20 feet from the top, and on Aug. 15 it was 26 feet from the top."

The Court: All they put in that well was acid.

Mr. Owen: No inhibitor.

Mr. Lyon: And those were not oil wells. That work we contend had nothing whatever to do with the acidizing of oil wells, or the Grebe-Sanford patent in suit.

Mr. Owen: Of course our contention is, Your Honor, while it wasn't dealing with oil wells it did familiarize Grebe and Sanford—

Mr. Lyon (interrupting): Sanford wasn't mentioned. Sanford is dead now, and the testimony taken at Midland showed Mr. Sanford was in charge of this work.

The Court: That was a brine well?

Mr. Owen: Oh, yes.

Mr. Lyon: And there was no inhibitor used in that work at all.

The Court: What did that show? You have read it to me.

Mr. Owen: It showed they pumped, as I recall, 22,000 gallons of 30% acid—hydrochloric acid, into that well over a period of I think close to two weeks, quite a long period.

The Court: I remember it was a long period. I thought about that. I suppose they have been treating their wells over there with acid for a good while. I don't know.

Mr. Owen: Not for a good while. The testimony taken at Midland showed they started in 1929, continued through 1930 and up into '31.

The Court: There is nothing in the report about its eating their pipes and pumps?

Mr. Owen: I don't know whether in that treatment but in most of those treatments they put the acid down below the tubing by a rubber hose, using uninhibited acid.

The Court: Doesn't say that.

Mr. Lyon: It does in the deposition, Your Honor.

The Court: All right. Put it down by that old method.

Mr. Owen: This other report is by Poffenberger and Grebe.

The Court: Now I want to put that down. Put in raw HCl—

Mr. Lyon: With no inhibitor.

The Court: With no inhibitor.

Mr. Lyon: Through rubber hose into a brine well.

The Court: Through rubber hose into a brine well. But the same kind of rock. The fact it is a brine well—

Mr. Lyon (interposing): They weren't trying to increase the productivity of a formation in oil.

The Court: No, but they were trying to eat out the rock, weren't they?

Mr. Lyon: The deposition says they were trying to eat a big hole around at the bottom of the well so they could pump a lot of brine in there, trying to get rid of this brine.

Mr. Owen: I think that is not a correct statement of the deposition.

The Court: Well, any way. I don't see—they were putting it down into a well—

Mr. Lyon: To eat on the formation.

The Court: But they did use a rubber hose.

Mr. Lyon: And a pump.

The Court: There must be some iron in the pump.

Mr. Owen: I think they used a glass pump, Your Honor.

The Court: Does the deposition show that?

Mr. Lyon: I think it did.

Mr. Owen: One of the depositions did; whether it was Poffenberger's or not, I don't know. This other report is dated July 21, 1930, and states that the problem was received on October 31, 1929. It is entitled "Dissolving Scale in Tubes with Acid using some Arsenic Compounds to Prevent Corrosion of the Iron Tubes."

The Court: That is a report made at the time?

Mr. Lyon: That has nothing to do with wells, Your Honor. It is a problem in one of the shops where they had some scale on one of the tubes.

Mr. Owen: This is offered to show that when this oil well problem came up Grebe had this information regarding the efficiency of arsenic as an inhibitor.

The Court: Dissolving rock, you say?

Mr. Owen: No, dissolving scale.

Mr. Lyon: Boiler scale in tubes.

Mr. Wiles: That report says the scale couldn't be dissolved.

Mr. Owen: Let me read the report.

The Court: As to that, they were then doing what was very old?

Mr. Lyon: That is right.

Mr. Owen: Yes. It brings to Grebe specific knowledge of the efficiency of arsenic as an inhibitor. They weren't doing anything new.

Mr. Lyon: This wasn't part of Grebe's invention.

The Court: He is just making more prior art, if you want to put it that way.

Mr. Owen: The report reads:

"Samples of silicate scale were obtained from Nelson Griswold at the Power Plant. He claimed they were not affected by concentrated HCl and concentrated HNO_3, so no work was done on the scale.

"The use of arsenic compounds to inhibit hydrochloric acid corrosion was checked by laboratory corrosion tests, using acid up to 6 N." That is 20% HCl.

"Strips of sheet iron, about 6" long and ¾" wide, weighing about 10 grams were used in the work. They were placed in 500 c.c. of acid and allowed to stand 24 hours before they were removed, brushed and weighed.

"Sodium arsenate and sodium arsenite are both effective in retarding corrosive action of HCl at room temperatures. In general the arsenate is the more effective except at the highest concentration used—10 grams per 500 c.c. However they do not prevent corrosion.

"The table given below shows the effect of both change of acidity and changes in the amount of arsenic compound."

Then there are two tables: I think, Your Honor, you better read the tables.

Mr. Lyon: Tables are pretty hard to read.

Mr. Owen: Whichever you prefer.

The Court: Let's do both.

Mr. Owen: I will read it to you first.

The Court: No, I will look over your shoulder.

(Whereupon Mr. Owen read the following tables)—

"500 c.c. acid—2 grams of arsenic salt Normality 1"—I can't give you the percentages. Mr. Rebbeck can. What is 1 Normality HCl?

Mr. Rebbeck: It is about 3 or 4%.

Mr. Owen: That was 3 or 4% HCl with no arsenic. The per cent loss of weight was 6.7. Then it was tested with sodium arsenate at the rate of 2 grams per 500 c.c. of acid, and the per cent loss of weight dropped from 6.7 for the raw acid to 0.3 for the acid with the sodium arsenate.

A similar test was made with sodium arsenite. The loss there was a little less than with the arsenate—0.2.

The next one, with a normality of four—

Mr. Rebbeck: That is 15%.

The Court: I see the Gravell patent came out July 31, 1928. I was wondering if they were checking up on things they learned out of Gravell to see how they worked.

Mr. Lyon: It says: "Subject—Dissolving Scale in Tubes with Acid using some Arsenic Compounds to Prevent Corrosion of the Iron Tubes." That is some tube experiment. It has nothing to do with anything in an oil well.

Mr. Owen continued with the reading of the table:

Loss in Weight in 24 Hours Expressed as Percentages

500 c.c. acid—2 grams of arsenic salt

Normality	Per Cent Loss wt. of iron no arsenic	Per Cent with Sodium Arsenate	Per Cent with Sodium Arsenite
1 (About 3 or 4% HCl)	6.7	0.3	0.2
4 (About 15% HCl)	28.8	0.3	1.2
6 (About 22% HCl)	100.0	1.7	5.5

Loss in Weight in 24 Hours Expressed as Percentages

500 c.c. = 6 N. HCl—amount of salt varied

Grams Salt per 500 c. c.	Per Cent Loss wt. No Arsenic	Per Cent with Sodium Arsenate	Per Cent with Sodium Arsenite
0	100		
2		1.7	5.5
4		1.4	2.2
6		1.3	1.7
8		1.1	1.2
10		1.4	.7

The Court: Does this record show when Dow first used a steel tank to haul inhibited acid, or any other kind of acid?

Mr. Owen: I do not know that the record shows, but I think that it is safe to say that it was after they started acidizing oil wells. They used wooden tanks around the plant.

The Court: Out to their brine wells.

Mr. Owen: Well, around the plant, from one of their plants to another, to haul acid, they used wooden tanks.

The Court: I am wondering when they bought the first iron tank.

Mr. Owen: I don't know. I think that it may be assumed that it was some time after they began to acidize oil wells. Now, how soon after, I do not know.

The Court: What do they keep this acid in, hydrochloric acid, in their plant? What do they store it in now?

Mr. Rebbeck: My understanding is that they use wood storage or rubber-lined steel.

The Court: They still do that?

Mr. Rebbeck: Yes.

The Court: There wouldn't any of them but what in time, would eat up a tank, with any of your inhibitors, if you were going to try to have permanent storage.

Mr. Owen: I rather think so.

My next offer is four pages from the Journal of the Industrial and Engineering Chemistry, for February, 1912, an article relating to the award of the Perkins medal to Herman Frasch.

I offer this merely to confirm the statements that have been made here several times that Mr. Frasch was a very prominent chemist. This is offered as PX-365.

(A photostatic copy of the article above mentioned was marked PX-365.)

Now, the next offers I have are made in view of the fact that defendant offered a copy of the Carr patent, and the file history of the same patent, the Carr patent, 1,891,667, offered as DX-11, and the file history is DX-11½.

And, enough has been said to indicate that it will be defendant's contention that that application disclosed the process of the Grebe-Sanford patent. In order to meet that claim, it is our position, in the first place, that that patent, nor anything in the file history, even intimates that Mr. Carr was the inventor or claimed to be the inventor of the process of using inhibited acid. But, in order to cover the complete field, I have copies of abandoned applications filed about the same time as the Carr application, one of them by Richard H. Carr and Howard C. Humphrey, method for increasing fluid production from oil wells, and this is marked "Case 172." The file number is not given on this document, but correspondence from their patent attorney to which I will refer, fixes or identifies that date, or that number. That was filed on June 30, 1932, serial number 620,180.

The Court: Do you want that a separate exhibit?

Mr. Owen: Yes, I want that as an exhibit.

Mr. Lyon: I object to that, Your Honor, on the ground it is not admissible against this defendant on any theory of law at all, and, second, that it is not competent, no proof of the document at all. We are not stipulating to that document.

Mr. Owen: If the technical objection that it is not competent because it is an uncertified copy is urged, we

will ask the court for the privilege of ordering from the Patent Office a certified copy on order of the court. We cannot get it without order of the court.

Mr. Lyon: Why can't you get it?

Mr. Owen: It is an abandoned application.

Mr. Lyon: Well, there are plenty of contract relations on this acidizing subject between you and the Pure Oil Company; you have access to their applications, licenses under them, and all that. I don't see how other applications that the Pure Oil Company may have filed are evidence of anything against this defendant in this case.

Mr. Owen: Well, they certainly show what the Pure Oil Company was claiming at that time; they were concurrently filed with the Carr application which you have presented.

Mr. Lyon: We have already explained to the court we are not claiming that Mr. Thomas or anybody in the Pure Oil Company conceived of adding an inhibitor to the acid. They were the ones that went and suggested the acidizing of the wells, the oil wells.

Mr. Owen: If there will be no contention that the Pure Oil Company, or someone connected with the Pure Oil Company made the invention covered by the Grebe-Sanford patent, or suggested the invention, then I will not make these offers.

Mr. Lyon: I don't know what you are going to claim for the Grebe-Sanford patent, but I think I will make it very clear we are not asserting, or do not contend that Thomas, or anybody connected with the Pure Oil Company, was the one to suggest putting any inhibitor into the acid used in acidizing oil wells.

Mr. Owen: Well, that makes it unnecessary to offer these.

The Court: I will proceed; it is overruled, and let you admit it, and if later it seems important and there is a question about its admissibility, I will pass upon it with greater care, but I will let you admit it.

Mr. Owen: Then I will ask that this copy be marked Exhibit PX-366.

(The copy above referred to was thereupon marked PX-366.)

The Court: That is abandoned application for increasing fluid in oil wells, filed June 30, 1932, by Richard H. Carr and Howard C. Humphrey.

The Court: And assigned to Pure Oil?

Mr. Owen: It doesn't appear on this copy, but —

The Court: The reason I am trying to get the fact about that, from what defendant said they may save time if we have that in the record, if they want to raise any legal question about that.

Mr. Owen: We will offer a letter from Edward H. Lang, who was the patent attorney for the Pure Oil Company who handled these applications, to Mr. Thomas Griswold, Jr., of the Dow Chemical Company, who at that time was in charge of their patent department.

The Court: Of Pure Oil?

Mr. Owen: No, Mr. Griswold was of the Dow and Mr. Lang, who wrote the letter, was of the Pure Oil.

The Court: Wasn't this application owned by the Dow?

Mr. Owen: No, it was owned by the Pure Oil Company.

The Court: You admit it was owned by the Pure Oil Company?

Mr. Owen: Oh, yes.

The Court: And Pure Oil are a licensee of Dow, is that right?

Mr. Owen: Yes, and Dow is a licensee of the Pure Oil under these various applications.

The Court: Dow is a licensee?

Mr. Owen: Under all the Pure Oil applications and patents. Now, the next one is marked "Case 174," an application by Richard H. Carr and Howard C. Humphrey for a chemical reagent for use in oil wells, filed October 10, 1932, serial number 637,099.

The Court: Is that another abandoned application.

Mr. Owen: That is another abandoned application.

serial number 637,099, and it is noted right here that this was assigned to the Pure Oil Company.

Mr. Lyon: Same objection, Your Honor.

The Court: Same ruling.

(The application referred to was thereupon marked PX-367.)

Mr. Lyon: We don't know when these were abandoned; counsel says they were abandoned, I don't know what evidence there is that they were abandoned.

The Court: I don't know whether that makes them better or worse.

Mr. Lyon: I don't either; he says they are abandoned, but there is no evidence of it.

Mr. Owen: The next is another abandoned application. This will be PX-368.

(The document referred to was thereupon marked PX-368.)

The Court: The same parties?

Mr. Owen: Yes, Carr and Humphrey, the same parties. The title of the case is, "Method for Introducing Acid Reagents into Oil Wells by Gas Pressures." It was filed October 21, 1932, serial number 638,950.

The Court: This is the file wrapper in each one of these cases?

Mr. Owen: No. This is the application which was abandoned.

The Court: All right.

Mr. Owen: Then I also have copies of the two agreements between the Dow Chemical Company and the Pure Oil Company, the earliest one being dated January 31, 1933, which I will have marked PX-369.

(The agreement referred to was thereupon marked PX-369.)

Mr. Owen: And the later one, dated June 30, 1934, should be marked PX-370.

(The agreement referred to was thereupon marked PX-370.)

Mr. Lyon: The statement was made a few moments

ago, Your Honor, that Pure Oil Company had no conflicting claims to inhibitors. I call Your Honor's attention to PX-367, which is one of the alleged abandoned applications.

The Court: October 10, 1932.

Mr. Lyon: I am not going to read the whole application, but it starts out by saying:

(Reading): "This invention relates to an improved compound or chemical reagent for treating the producing formations of oil or gas wells to facilitate the flow of a desired fluid into the bore of such a well, and it is an outstanding object of the invention to provide an approved reagent which possesses the capability of reacting with such producing formations to partially dissolve or disintegrate the same or increase the porosity thereof, in order to render such formations around the well bore more permeable to the flow of the desired fluid into the bore, and thereby increase the fluid output of a well so treated."

Then it discusses the earlier application and says:

"We have found in the operation of our process that such an acid reagent while highly effective in increasing the porosity and fluid output of the producing formation, possesses the disadvantage of attacking the metallic members of an operating well, such as the ordinary tubing and casing, into which the reagent comes into contact, causing their premature impairment together with high replacement costs."

Then on the next page it says:

"We have discovered that improved resistance of the metal in the well bore to the corrosive effects of such reagent may be obtained through the use of a reagent modified in its action by the addition thereto of relatively small quantities of compounds belonging to the nitrogen groups, whereby the reagent may be passed harmlessly through metallic members or over metallic surfaces without exerting any material detrimental action thereon. In our aforesaid prior application, we have disclosed the use of an acid reagent consisting of hydrofluoric or hydrochloric acids, or a mixture of hydrochloric and nitric acids."

And, it mentions arsenic and in the first claim in the patent it calls for arsenic specifically, and in the sixth claim it calls for a whole group; it says:

"An acid reagent for treating the producing formations of oil or gas wells to increase fluid production therefrom, comprising a mixture consisting principally of a halogen-containing acid."

Which hydrochloric is one:

"—and a relatively small amount of a compound belonging to the nitrogen group."

The group of inhibitors that the patent specifies.

Mr. Owen: This application, Your Honor, was filed on October 10, 1932, after the Grebe-Sanford patent issued, and this is what the invention, alleged invention was: "In our prior copending application, serial No. 620,180, filed June 30, 1932"—that was the date of the Grebe-Sanford application also, you will recall—"we have set forth a process for accomplishing the above by the use of a reagent in the form of hydroflouric and other equivalent acid which is introduced into the well bore through the customary tubing or casing and advanced"—

The Court: This application, PX-367, was evidently prepared and filed for the purpose of getting into interference.

Mr. Owen: Oh, no.

The Court: It was after your patent had been issued: wasn't this after your patent had issued?

Mr. Allen Owen: Yes, Your Honor.

The Court: Well, they were seeking interference.

Mr. Allen Owen: They didn't copy the claims of the Grebe-Sanford patent, which they would have done had they been seeking an interference.

The Court: Maybe that is right, but they certainly would have got into interference with it.

Mr. Allen Owen: No.

Mr. Owen: No, the Grebe-Sanford patent is confined to the use of hydrochloric acid for acidizing limestone formations, and this is for hydrofluoric acid; that is an entirely different acid.

Mr. Lyon: That is just one of the acids, it mentions hydrochloric also.

Mr. Owen: It says:

"Hydrofluoric and other equivalent acid."

Now, we will go to the claims; that is the only acid specifically mentioned.

Mr. Babcock: No, hydrochloric is mentioned in there.

Mr. Lyon: No, it is mentioned in there.

Mr. Owen: All right, give me time. They go on to say:

"We have discovered that improved resistance of the metal in the well bore to the corrosive effects of such reagent may be obtained through the use of a reagent modified in its action by the addition thereto of relatively small quantities of compounds belonging to the nitrogen group, whereby the reagent may be passed harmlessly through metallic members or over metallic surfaces without exerting any material detrimental action thereon. In our aforesaid prior application, we have disclosed the use of an acid reagent consisting of hydrofluoric or hydrochloric acids, or a mixture of hydrochloric and nitric acids."

Now, that refers to the previous application.

The Court: That does refer to hydrochloric.

Mr. Owen: Yes. I want to read these claims, and then I will go to the previous application.

"An acid reagent for treating the producing formations of oil wells to increase fluid production composed of a mixture consisting principally of hydrofluoric acid and a relatively small quantity of an arsenic compound."

Now, they knew by this time that the hydrochloric acid that Dow was furnishing them for treating their wells contained arsenic as an inhibitor. Evidently Carr and Humphrey felt that they could accomplish something different, perhaps in different formations, by adding an inhibitor to hydrofluoric acid, and therefore they put in this application which didn't copy any claim of the Grebe-Sanford patent, and no claim in that application could have been placed in interference with the Grebe-Sanford patent.

The Court: Couldn't they make them copy their claims?

Mr. Owen: Yes.

The Court: I know they tell them to.

Mr. Owen: But they weren't claiming the same invention, you see.

The Court: You mean they are just claiming a different acid?

Mr. Owen: A different acid, yes.

The Court: Well, your patent would cover that.

Mr. Owen: No.

Mr. Lyon: What about claims 6 and 7, Mr. Owen?

The Court: Just a minute, please. All right.

Mr. Owen: I find I was mistaken, as I frequently am on documents I haven't read for several years.

The Court: That relieves me again.

Mr. Owen: There is a claim, there are two claims in this patent—

Mr. Lyon (interrupting): This isn't very important. We can't prove that these fellows made this invention. And in view of the tie-up of Dow and Pure we can't get them to give us any information to prove they made this invention.

Mr. Owen: What did your witness Thomas say? He was an honest witness. He said he made no claim to having made use of the inhibitor.

Mr. Lyon: Mr. Carr evidently claimed he wasn't. So we are wasting time.

Mr. Conner: Your Honor, there is no undue tieup between Dow and Pure, if I may state so.

The Court: There is an agreement.

Mr. Conner: A definite agreement.

The Court: You pay them a lot of money.

Mr. Conner: Undoubtedly we do.

The Court: And you did that to get rid of this danger that you had they were claiming invention.

Mr. Owen: Well, there is another element in these agreements that I haven't referred to which I should have referred to before. Both of these agreements provided that

Pure should purchase large quantities of hydrochloric acid from Dow. That was another consideration that passed to Dow. Paragraph 5 of the original, and I think the same is copied in the other agreement, states: "Dow hereby agrees to sell to Pure and Pure agrees to purchase and accept from Dow the merchandise herein described for a period of ten years from the date hereof."

The Court: I have so many lawsuits that are settled by exchange of licenses, I can visualize pretty well what happened in that. There was a contest on between Pure and Dow evidently as to who had the inhibitor right. And that is all either one of you had a claim for; neither of you claimed to have done anything different down in the ground, in the rock, except very remotely.

Mr. Owen: The Carr patent, Your Honor, which is specifically mentioned in these agreements is a patent for a process for treating a well which does not claim the acid feature at all. It is the process of carrying on the treatment by first filling the well tube with oil and forcing that oil up between the tubing and the casing, and then shutting off the top of the well head so that the space between the tubing and the casing is filled with oil while the acid is being forced down the well and into the formation. That is the Carr patent which does not claim anything about the use of inhibited acid. We got a license under that patent.

The Court: I haven't discovered anything new about what the acid does down in the wells since 1896, so far as what it does to the limestone. No witness has testified to anything new.

Mr. Owen: No. I don't think there is any different action, when it gets right down there.

The Court: So the argument between Dow and Pure must have been over inhibitors and not over what the hydrochloric acid or some other acid will do with limestone.

Mr. Owen: Well, I must disagree with Your Honor, because there was no controversy between Dow and Pure as to who invented inhibitor or first used inhibited acid for acidizing an oil well. There was a misunderstanding as to

what each party was claiming, and I think they thought they were overlapping in their claims, but when they came to find out what each party was claiming, there was no overlapping, and each only got what he was entitled to.

The Court: What did they have that Dow wanted? What did Pure have that Dow wanted?

Mr. Owen: They had this Carr contract, or this Carr patent I have just told you about, which is used in treating wells and they had four or five other pending applications.

The Court: What does the Carr patent do?

Mr. Owen: That is the one I just told you about, that covered a process of filling the well tubing with oil, and forcing the oil up between the tubing and the casing, and then closing it off at the casing head, so that when the acid is forced down into the well it cannot get up between the tubing and the casing. But there was no controversy between them as to who was the inventor of using inhibited acid for acidizing oil wells, and Mr. Thomas very frankly stated he made no claim to any such a subject. That is all the evidence we have, Your Honor.

The Court: I don't see what difference that makes, anyway, in a case in which I haven't any proof that they were the first.

Mr. Owen: I don't think that it makes a particle of difference. It was dragged in by Mr. Lyon in their defense, and I thought it was up to me to show the whole picture, and I don't think it has any bearing on the issue here.

The Court: I don't see that it does.

The court stated that all exhibits which had been offered during the course of the trial would be considered as having been received in evidence.

PROCEEDINGS ON SETTLEMENT OF FINDINGS OF FACT

Mr. Owen proposed the following finding: "It is of great importance to increase the ultimate total production of the well by making it possible for the ground pressure to force a large proportion of the total oil into the hole. It is the accepted belief among oil geologists that the methods of operating prevailing before 1932 left about 2/3 of the oil in the ground."

Mr. Lyon: I should think that word "left" in the next to the last line there, it would be safer to say "may leave" because I don't think this court should be put in the position of finding as an absolute fact that the oil geologists have an accepted belief. We only have one witness, and if we could leave a little latitude it wouldn't hurt the finding for Mr. Owen's purpose. You might say "may leave about 2/3 of the oil in the ground." That is a speculative proposition.

Mr. Conner: It is the belief of all petroleum geologists that a very high percentage of the oil in the ground was left there, even after the well had finished its economic production.

Mr. Lyon: That may be true, and I imagine there is a great deal left after you get through acidizing. But, to find as an absolute fact it is an accepted belief that there is two-thirds of it left, it seems to me, is going too far. I think that the finding should allow some latitude.

The Court: I like it this way better: It is estimated by oil geologists. Something like that.

Mr. Lyon: I think that is better.

Mr. Owen: All right. Methods of producing, then.

Mr. Lyon: The methods of production. All right. That is all right. Then "The methods of production" instead of "operating." The "operating" means how they operate their pumps and their machinery.

The Court: The whole lawsuit was tried before, and

this time, to make it appear that the discovery of this acid that doesn't eat the pipe has cleaned out the ground with all this oil. Now, I haven't that notion at all, and I want to emphasize it on here. I haven't a bit that notion, that it is all due to this, because the acid with the inhibitor in it that goes into the rock doesn't eat the rock any different at all than it ever did, and if they had figured some way to shorten up their seal, there might have been some trouble and done something, but when they got around to do it in that way, they would never have let all that oil stay down in the ground just because they did have the oil. I am going to have much to say about that before I am through, but I want you both to know now that that is my idea, so I won't be making inconsistent findings of fact.

There is one right there. The very first sentence in the opinion out there, I assume it changes a little bit later on—I am not taking the time to look that up, but the first thing said by Judge McDermott—I would like to find that here—

"The object of the invention is to increase the recovery of oil from wells in a limestone formation," and so on.

Now, that isn't the object of this invention. The object of this invention is to prevent acid from eating iron. That is the object of this invention, and to say the other is just as ridiculous, and any written opinion I write now must not put a word in that is critical of anybody else, because people ought to be tolerant and I don't like that sort of thing in people, and I don't mean that sort of thing, but I only mean to emphasize my views about this patent, and I might just as well begin to do it here.

That is not the object of this, any more than to say the object of it is to increase bank accounts. You can keep on going back and back with your objects, but it just shows, and it results from notions like you got in this finding right here for me to sign that breaches that thing.

Later on it does find that about the iron in this opinion, but right at the outset you can see how Judge McDermott, the way this case was tried before and the way it has been

tried this time, keeps you looking down in the ground at that acid eating the rock.

Well, there isn't any invention about that at all. In this case it doesn't eat the rock any different than it did in 1896, when that fellow invented the patent to eat the rock. It doesn't eat it any different, and any judge that thinks about this case ought to have that in mind, that the acid with the inhibitor in it that goes out into the rock and does its job there, isn't eating it any different, isn't going to get any more of the oil out.

And, here is a patent that I am hearing, and that the Tenth Circuit heard, and is aimed at preventing acid from eating iron, and that was to be put into this case early and hammered in, because it has got started and I can see the purpose of it.

The patentee, when it started, thought they had a patent for eating rock, and they had to back up and get all you can get through the Patent Office, and they have kept that in all the way through right up to now, and it is right in this claim, and I don't think that. I don't believe that. I am not going to find that at all. I am going to find it just the other way.

This is a patent to prevent acid eating iron, and we will have to talk about that later, but that is all it is. It is not a patent that does any different down in there at all, and it won't get any more out of the earth than it would if you did not have the inhibitor in. Not one bit.

Now, in all of these findings I am going to watch for that, because you can see that when a patent that is of the kind that isn't on anything that it does in the rock at all, and the judge who has reversed the case and written opinions—but, the way the case is tried, and the record, and the emphasis it puts on it, it starts out by saying: "The object of the invention is to increase the recovery of oil from wells in a limestone formation and is obtained by injecting an inhibitor," and so on.

He does say later on: "The genius of the invention is in the use of the reagent," and all that, but that isn't—that

is on the facts now that we are finding here. I want to be careful about the findings that I make here, so that they will disclose my views about these things.

Now, I don't think that the percentage that they get now and the percentage that they got before this has an awful lot to do with it, because it doesn't eat into the rock any more or any better, nor gets that off any better. It is only a problem of getting it down in there. In this case you can read the record. You read the testimony in this case. The testimony is all pretty near about how much more oil they got out of a well when they acidize it than they do if they don't acidize it, when the test of the profit would be how much less iron did it eat with the inhibitor in than it ate with the inhibitor not in. There is the test. That is what this patent aims at, and it has just got started talking about the other thing, and this decision is going to be on the other basis and on the other theory. I do not see it at all. I don't believe that other theory at all, and I cannot go along with it at all, and I thought when we got there I might better let you know.

Mr. Owen: Of course, by not answering Your Honor's remarks at this time, I do not want to be taken as agreeing with them.

The Court: I know you don't. We talked about this all the way through. There is no use to wait any longer to tell you what I think about it—"increase the ultimate total production of the well"—I am going to cut that last sentence out. I am not going to find that, I just refuse that last sentence in its entirety. It shows it is testimony. All of these other things they do, make the acid go in easy, they all help some. Your blankets, that had some, I don't know, there are so many things that have been done, that it is just another thing steering on the wrong track to find that it makes any difference in this case. How much on the total, because of lack of knowledge about a thousand different things. If I had only the patent for getting the acid back out of the well, put this finding in, and the court didn't study the record carefully, might reach the conclusion,

"Well, it is all due to that patent," then to find out how much they were getting out before Chamberlain pulled his acid back out of the well, why, give it all to that one. We have a lot of things can happen all the way down through, and I don't think that is helpful. I think it is misleading.

Mr. Owen: "As early as 1895, Frasch and VanDyke, working jointly, undertook to overcome the inherent difficulties above outlined by forcing concentrated acid, preferably hydrochloric, into the pay around the well to enlarge the openings, remove accumulated obstructions, if present, and free up the flow. Frasch, at the time, was one of the greatest and best known industrial chemists. He originated the methods of sulphur mining still in use for the production of most of our sulphur, and he developed the refining methods which made the oil from the Lima, Ohio, field usable. He was later given the Perkins medal, the highest honor obtainable by an American chemist."

The Court: Who introduced him and gave it to him? I ought to put that in there, oughtn't I? I don't want it, but that sounds like a cum laude decoration. It is decoration day for graduates.

Mr. Owen: Well, the article is in evidence, Your Honor?

The Court: I know it. There are a lot of things in evidence. I will have this just a mile long. I can make a long speech about all the fine witnesses in here, where they got their degrees and how much, but I don't intend to do it. I don't know. Well, let's see, maybe it is agreed to. Many of these things, they aren't harmful.

Here is VanDyke. It sounds like the way the Republicans put a man in nomination for office.

Mr. Owen: Shall I continue?

The Court: Yes.

Mr. Owen: "VanDyke was a prominent member of the old 'Standard Oil Group' in Cleveland, was later head of the Atlantic Refining Company, the Standard Oil subsidiary in Pennsylvania, after the dissolution of the old Standard Oil Company in 1911 continued at the head of

this company, and was a little later also the head of Atlantic Producing subsidiary."

The Court: I won't give it even if you both agree to it. That is just too ridiculous for a finding of fact, most of that. It is just a laudatory speech. I never heard of such a finding of fact by a judge. Just a laudatory speech.

Mr. Owen: No. It just tells what his connections are.

The Court: What a great man he is. What has that got to do with it?

Mr. Owen: The purpose of it is this, Your Honor. Perhaps you don't appreciate what we have it here for, but the purpose of it is to show that the men who controlled the Frasch patent were in a position to introduce and extensively use that invention throughout the lime fields in the country. We show by testimony taken here in the form of stipulations some of the leading men in the Atlantic Producing Company, they testified to these—

The Court (interposing): That is what you get by that sort of testimony. Judge McDermott thought the Mellon Institute had found it so difficult that they recommended something that wouldn't work at all, when, on the rehearing, it disclosed that that wasn't the situation at all. That is the danger with this sort of argument and theory.

Mr. Owen: Here is a prior art patent, the Frasch patent that is being relied on very strongly to show there was no invention in the Grebe-Sanford process, and the proofs show that the Frasch process was used for a period of a few months down in Ohio and then it disappeared. Now, I think it is very pertinent to show that the men who controlled that Frasch process were in a position to have given it extensive use had it been a practical process.

The Court: Yes. And you want to argue that that is the reason it failed, because this ate the iron, and I can think of more reasons that it might have failed from. That is just one. There isn't a word in the record to show that is the reason it failed, and that is the reason they gave them up any more than you did over here in Midland. There is a good deal more reason that Dow was notifying their

customers that they were infringing than because their acid was eating their pipe a little.

Now, the acid was eating the limestone, and I am going to keep talking about that all the way through in this record so that when this case gets to the Court of Appeals they are at least going to know that I have got the notion that what this patent is about, all there is to the claim is that they have got an invention that it wouldn't eat the iron. That is all it is about. There has been some argument here that this patent works different, because it doesn't eat up too much of the acid, that the acid is stronger when it gets down there. Now, that is all just argument. The patent wasn't granted on that. There has been argument here, it is suggested and it was argued in the other court that "Well, they didn't know how acid with an inhibitor in was going to act in eating the limestone."

Now, that was in the other case and it was tried to be injected into this case. It isn't in this case, there isn't anything to show that anybody ever thought that inhibited acid would act different way down in the bowels of the earth than it did above, and that that held this back. There isn't anything of that kind in this case, and I want to emphasize it so there will be no question about it, that that is what I think about it.

So, it is easy to go wrong in a thousand places in this case. Now, that is absolutely wrong reasoning. There isn't anything in this case that justifies the argument that the scientists and the operators and the practical men were being held back just because they didn't know—they knew about inhibited acid, but they were afraid if they put inhibited acid in it wouldn't act down in the bowels of the earth and eat the rock as good as it was if it wasn't in. Well, there isn't anything to make anyone think that. That is just argument without justification for it.

Mr. Owen: I am sorry to disagree with what Your Honor states.

The Court: I know you do, and the whole case has been tried on the other theory, but I don't agree with it, and I want it known I don't agree with it at all.

Mr. Owen: No, we haven't advanced that theory as a basis for the standing of this Grebe-Sanford patent. I think I should tell you right now what our theory is, if it isn't clear. We claim that by the Grebe-Sanford process we do two things, we protect the pipe and make it unnecessary to use special pipe or dump bailers, or anything of that kind to get the acid down into the well, and that because of the fact that it has been protected against eating the pipe you have a stronger acid to do the work that it is intended to do when it gets there.

Now, Your Honor says that is an afterthought. I want to tell you that is not an afterthought. It is in the record, it is in the Grebe-Sanford file history. During one of the arguments—may I read this—

The Court: I say that sort of a theory is just as far away as it would be if you invented a tank to haul to a well to put it in and because your tank prevented slopping and losing some of it on the way to the well you tried to hitch it up with the acid eating the rock when it got into the well and say, "I have got a new invention, I don't slop out so much, and I am going to use that down in the well, and therefore when it gets down and eats the rock," and so on and so on; I say that you would have to measure that; you couldn't measure that by saying how much more rock I could eat and how much more oil I could get, therefore how much good I could do by my invention that would prevent the tank slopping acid out. I say you have got to stand on your tank and the amount of acid you lose and the value of the acid, and that thing, and so down here you cannot carry that on. What difference does it make except for your loss in your acid? It doesn't eat any different down in the well and it doesn't consume the rock any different, and the amount of acid you lose is like the amount of iron you lose.

You just get credit for that, if your patent is good, and good as the first to use inhibitor. But you ought to measure it by the value of the acid and by the damage to the tubing, or the lack of damage to the tubing, and not go

on down into the well and talk about how much formation could be eaten out, and then how much oil could be obtained, and then how much money could be gotten for the oil.

Mr. Owen: Well, I think we are entitled to measure it by the results we have obtained.

The Court: Well, I say you are entitled to measure the results obtained by that little additional acid that you save, by its not being used up eating the pipe, and the same as if you had a patent on the tank that—transportation tank that prevented some slopping over. You wouldn't think of going on down where your destination was and saying how much work would that 50 cents worth of acid have produced, and earn me a lot of money when you got there, but you would measure it by the value of the acid you lost. Now, that is logic, and the other is just misleading somebody and trying to get to a wrong decision, and that is in the other case and I am determined to keep it out of this case, so that—

Mr. Owen (interposing): Well, I can't agree with that view of the invention at all, Your Honor.

The Court: No, I know you can't.

Mr. Owen: Well, we have here two patents, both aimed at doing the same thing. One of them the Frasch patent and the other the Grebe-Sanford patent. One of them, the earlier one, went about it in an impractical way which never made any impression on the art. Now, we come along after there has been a crying need for a practical way to carry out that process for 40 years, we come along and in a simple way we show that that process can be carried out, and, in carrying out the process in our way, we do three things.

In the first place, we protect the tubing and, therefore, we make it unnecessary to carry around a special tubing or dump buckets.

In the second place, we carry the acid into the formation in substantially the full strength in which we deliver it into the pipe.

The Court: There is nothing in your patent about that.

Mr. Owen: I want to read it. It is in the file history.

And, in the third place, this patent points out something that is really important, which has not been emphasized, but it is really important in carrying out this process, and it is the thing that all of the licensees and all of the infringers do, and that is instead of using 30 or 40 per cent strength hydrochloric acid as Frasch proposed to do, we propose to use from 5 to 20 per cent hydrochloric acid, with a preference for 15 per cent, and the 15 per cent acid is what has been used generally by plaintiff, its licensees and infringers.

Now, Your Honor, if you remember that curve of the corrosiveness of hydrochloric acid, it starts in down in the lower left-hand corner with a very low rate of corrosion at 5 per cent. At 10 per cent it is a little higher, and at 15 per cent it is still higher, but still way below the corrosiveness of the acid which Frasch proposed to use. Your Honor remembers that curve.

Now, we did those three things, and as a result of those three things we have made practical and successful a process which broadly was suggested by Frasch 40 years ago.

Now, I don't see how these inventors, who have made that practical, can be thrown out of the window on the statement that all they did was to show how to protect the iron. They did more than that. They made this thing successful where it was a failure before.

The Court: It doesn't do one whit different after it leaves the pipe than it did before.

Mr. Owen: When you get it down there, I admit that is true. Coming back to the proposed finding, Your Honor, I say that it is pertinent to show that the failure of the Frasch process was not due to any inability of the owners of that process to put it over if it was successful, and if it was practical; and I think that these findings regarding Frasch and VanDyke are pertinent to these issues.

The Court: You mean as to their standing? Well, now, we go back down in Ohio where they used it, and I suppose if they were dumb, I don't know, would it be all

right for the other side to show what a dumb lot of fellows they were that were using it down there?

Mr. Owen: Maybe they were dumb, but I don't think so.

The Court: But, I say, I don't think it is material. How about the first part of that? Mr. Lyon, I haven't heard from you. I am going to strike out all this laudatory talk about those gentlemen.

Mr. Owen: I don't care about the laudatory talk. I wanted to get in this record here that these men were in a position to get that process over, had it been a practical one.

The Court: What about the first sentence there?

Mr. Lyon: I think they are spending most of their time on the laudatory work, and they are not completing the finding.

The Court: I will deny this one as it is there.

Mr. Owen: In its entirety?

The Court: Yes. I can't take the time to modify them so much like I did yesterday afternoon. I just spent all the afternoon taking requests which were wrong, and trying to make them good.

Mr. Owen: I don't want to be persistent, Your Honor, but it does seem to me that as to VanDyke—let us cut out Frasch, whether he got a medal or not—but as to VanDyke, the half owner of the patent, I think it pertinent to show that he was a prominent oil man at the head of a large oil industry which owned and controlled large lime fields and was in a position to put that process into operation had it been a commercially practical one.

The Court: Then I would want to go in and know how much attention they paid to it. I have known men to be directors of banks and not go to directors' meetings more than twice a year, and have a lot of money invested in the same bank. This whole thing has been, as I see it, built upon that sort of straw man. I call that a straw man.

Mr. Owen: You have got to account in some way for the fact that that Frasch process was tried out in a half

dozen or more wells over a period of three or four months and then dropped, disappeared.

The Court: I can think of a lot of reasons, many things dropped. Why was this dropped over here in Midland when those men started to put down their acid?

Mr. Owen: Because it did so much damage to the well.

The Court: I don't think so. I think it stopped because Dow sent so many notices to their customers and they only had $400,00, was it, capital stock.

Mr. Owen: No. They kept right on. The fact is that during the time they were getting the damage they were not infringing the Grebe-Sanford patent, but they didn't stop when they got the notice. Instead of stopping they adopted the Grebe-Sanford process and began to use inhibited acid, and continued to use it for two years, nearly.

The Court: I can think of so many reasons why things start and stop. Suppose they got one of those wells down like that mine they sued that went to the Court of Appeals and was affirmed, and the plaintiff got $8,000, because they didn't put a blanket in the well. They don't have any blankets this deep. Suppose they had to put it down in these wells and got brine. "Bing," it would have been said that is an awful thing and would have killed it for the next ten years. I don't know whether or not it would have been for 20 years, if that was in the first one. Supposing that happened to be the first well, it wasn't at all, but so many things put things out of business that it is unfair, and this record has been, as I see it, and the other case, those things were emphasized, the only reason in the world the judge held your patent good, that is all he had, he says in substance that is all on account of your wonderful success, and he turns around and gives you all this, and I can not find in the record you ever showed you followed your own patent down there on that record. Maybe you did, but it is a pretty weak showing, if it can be dug out of there, that you followed your own patent.

Mr. Owen: Mr. Dougherty of the Oil Makers was on the witness stand and he told Your Honor why they went

out of business, it wasn't because of the notice of infringement at all, because they continued to infringe for a number of months after that.

The Court: They were operating on a shoestring.

Mr. Owen: The reason they went out of business was they were operating down in Louisiana and out in Texas and the price of oil went down to 10 cents a barrel and they had contracts, their pay was partially in oil, and they couldn't make good continuing through.

Mr. Owen: "19. Prior to the date of the application for the patent in suit, the Gypsy Oil Company had a problem in the Glenpool Field in Oklahoma, caused by formation of 'Gyp' scale on the casing, tubing, working barrel and pump rods of an oil well, which formation interfered with pumping of the well and necessitated frequent shut-downs and loss of time for removing rods, valves, etc., and cleaning off the scale. A suitable scale solvent was sought which could be used in the wells to remove scale and thereby to avoid frequent 'pulling' jobs. The problem was submitted to the Mellon Institute at Pittsburgh, the result of steps made at the Institute being contained in a report by Dr. Westcott. The report, while not made public recommended the use of hydrochloric acid as the scale solvent, and the addition of Rodine, an inhibitor, to the acid, to prevent its attack upon the metal parts of the well. The report also suggested that the use of the acid in the well might also remove Gyp from the face of the sand and thereby increase production."

The Court: Well, that sounds all right.

Mr. Lyon: Well, Your Honor please, its is evidentiary, I think, and the way I have it is in my proposed finding, 33:

"Such an inhibitor was added to hydrochloric acid by the Gypsy Oil Company in 1928 for the purpose of reducing the corrosive action of acid upon the well pipe and equipment in the well when introducing the acid into a well to remove calcareous scale and deposits therefrom."

That is the ultimate finding as to what resulted from it.

I say in 34:

"Such use of hydrochloric acid containing corrosion in-

hibitor was reduced to successful commercial practice by the Gypsy Oil Company in 1928, and was not a mere abandoned experiment."

I think Your Honor is entirely familiar with the fact an abandoned experiment is something that was not completed. It doesn't—if you do the job once, and successfully do it, it is not an abandoned experiment at all.

The Court: But is that inconsistent with this?

Mr. Lyon: No, it isn't inconsistent with it.

The Court: In any respect?

Mr. Lyon: I think this could be adopted.

The Court: That sounded all true to me. It is open to the objection that I am telling what is in a report, but it seems to fit in with what has gone before, and I say as to what criticism I have offered about requests to charge, I recognize how difficult they are to draw and how you can't draw a nice dividing line, only my thought was the others were just top-heavy on that side, but this would cross the line, but it wouldn't seem objectionable to me to state what is in that report. It fits in with the other. And I say it is one of those places where the twilight zone is bigger than the rest of it. I will give that one. It sounds to me like the fact about it, and you are getting over into a place, that, I think, is very material. What was done.

Now, the ignorance of someone, of some folks, I don't attach very much importance to. What they don't know. You take for instance the gentleman from the Bureau in Washington. I do not consider it of very much importance what he doesn't know. I don't consider it of very much importance what the Bureau doesn't know, in deciding a case.

The prior art is made up of things that people do know, and what individuals do not know. Now, that is the prior art, through publications, through patents, and through reducing to practice other things, in those three ways, that the world does know, and this country knows, about reducing to practice what they do know, and that isn't affected by what people don't know. I think there is a

thing that hasn't been recognized in this. It is running through here to show what people don't know.

Now, he may be a most excellent lawyer, and there are plenty of things in the law that he doesn't know. Now, it would have no importance to call him and show what he didn't know, and I don't in these patent cases—we could make a record without end if we were going to show when we came to the prior art what people didn't know. Now, what we do show properly in the prior art is what was known, and that again is emphasized by the fact that we see plenty of people travel the same road in inventions. You can find it here, things that are known to the publications somewhere, to the patents somewhere, or to reducing to practice somewhere, but here comes along an individual as wise as they are, but he doesn't happen to know it, and he does all the work and uses all the actual ingenuity of the orininal inventor, and yet he can be rewarded because he isn't rewarded for what he didn't know or what anybody else didn't know. He is only rewarded for being the first. We have to keep that in mind in these patents, prior art. 19 is given.

Mr. Owen: 20 relates to this Gypsy Oil Company alleged prior use. "The engineers of the Gypsy Oil Company advised against pouring any large quantity of acid containing the inhibitor into a well and suggested methods other than the one recommended in the Wescott report whereby the acid might be employed for removing gyp from the well tubing, casing, and pump parts, and even from the face of the sand without permitting introduction of the acid into the producing formation, and recommended that some such method be tried as an experiment. The evidence is not complete as to how the experiment was conducted, but Dr. Knappen, testifying, and the Gypsy Oil Company engineers, whose reports on the experiment appear in the Gypsy Oil Company executive file agree that production of the wells was not increased."

The Court: Denied, for several reasons; one is that it is just telling what somebody has testified to, and if the

Court wants to know that, let them read the record. It is not for me to summarize, reduce to narrative form the testimony of witnesses, and, in the next place, this is a side thing, this is the one—is this the part where they let it run in gradually?

Mr. Owen: Yes.

The Court: What has that got to do with the cause of the—after the Mellon Institute made a recommendation of something and they do it and it works just the way they recommended it exactly, now, somebody out there tries out another thing and didn't succeed. I don't see what that has got to do with it. Why show a failure in something on some other side line? That is misinterpreting of the prior art again to show how little somebody knows. We are concerned with what they did know and what they did do, not how little somebody knew, whoever he is. I deny that one for two reasons.

Mr. Owen: I would like to present another finding on this Gypsy Oil matter which I will have to prepare. I think it ought to be in.

The Court: Maybe you can bring it up in connection with their requests, Mr. Owen, and I will give it careful consideration then, because I know they have got one that isn't passed on. I have heard it. It sounded about right to me.

Mr. Owen: "21. Subsequent to November 12, 1928, and at various times during 1929, 1930 and 1931, a number of further tests"—well, that relates to the same thing.

The Court: Yes. I deny that. They were trying to treat their pipe, as I understand it. If they wanted to, why not plate it the way this man Frasch, the old 1896'er suggested?

Mr. Owen: No.

The Court: Is that the one where they were putting it in gradual, a little bit at a time, letting it trickle down?

Mr. Owen: Yes. They weren't trying to plate the pipe. They were trying to prevent the formation of the scale on the pipe instead of removing it after it had been formed as by the Dr. Wescott—

The Court (interposing): I would call that an unsuccessful and abandoned experiment to something that didn't affect the prior art. That doesn't lessen it. It doesn't show that the thing Mellon had suggested was impractical. It doesn't show that. It doesn't show that the thing that is now being done was difficult. It just doesn't have any bearing on the thing. Chaps out there, after they had performed this successful experiment, and got their results the way Mellon recommended, they had a thought and they tried it out, and it didn't work. That is all there is to that, and I don't think it should affect this lawsuit at all.

Mr. Owen: Well, it seems to me that it has some bearing in this connection, that the last time they tried the Wescott suggestion was on the William Barryhill Well No. 8, March 18, 1931. Then there was nothing more done with that treatment, so far as this record shows, I think there was nothing ever done.

Mr. Conner: Maybe Your Honor doesn't have in mind that there is a distinction between gyp removal and the treatment of the formation.

The Court: I do have the difference, but what difference does it make between the time you stopped and you started with it?

Mr. Conner: Well, I tell you the way I see that gyp evidence was in the last suit, the defendant was maintaining that this practice of Gypsy was a prior use of the Grebe-Sanford patent.

The Court: I know. But, Judge McDermott evidently thinks there is something wrong with that. He thinks that was an unsuccessful thing out there.

Mr. Wiles: Well, it was.

Mr. Conner: It certainly was.

The Court: You do it the same way, and it is successful. Why?

Mr. Conner: I don't know why we have made it successful, but we sure did.

The Court: I know why. You have got a big fine outfit, but that doesn't make a patent.

Mr. Conner: Are you trying to tell us that the Gulf Oil Corporation is smaller than the—

The Court (interposing): No. But, they aren't good oil treaters like you are. They hire you to do it, don't they?

Mr. Conner: The Gulf Oil Corporation, Your Honor, I think without controversy spends the most money and has the largest laboratory and does the most research of any oil company.

The Court: You treat their wells for them.

Mr. Conner: They were trying to treat them then.

The Court: Who does treat them now?

Mr. Conner: We treat some, and I think Halliburton does some.

The Court: Don't you see you are arguing to me because they didn't do it, the reason they didn't do it is because they didn't know enough. They are not doing it. It is because you have got a good outfit, just like I hire a sheep shearer, because he is a good shearer. I know how to do it, but I am not a good sheep shearer, and I am busy with other things, and I hire him to do it. He has a little outfit down there.

Mr. Owen: When they started to use Dowell treatments, we did not have a good outfit.

The Court: Well, you figure out some way that will explain why treating gyp failed back in 1929 and why it succeeded in 1932, and thereafter, and you did it in exactly the same way.

Mr. Wiles: We didn't do it in 1932. Much later than that.

The Court: There is a long interim in there, in gyp treating.

Mr. Conner: I don't know whether we are talking about the same thing at all. Gyp treatment is an entirely different thing from acidizing wells.

The Court: I know it is.

The Court: Well, here is the finding I am willing to make: "During this time, prior thereto, and subsequent thereto, wells were treated with acid without inhibitor."

Mr. Owen: That is right.

The Court: That is as far as I can go, if that is of any help to anybody.

Mr. Owen: This 24 will read: "After September 11, 1929, the next Gypsy Oil Company well to be treated with inhibited hydrochloric acid was the Lovett No. 1 well, producing from a limestone formation in the Ritz Pool, Kansas, which was treated with inhibited hydrochloric acid by Dowell, Incorporated on February 10, 1933, for the purpose of increasing the oil production from the well."

Mr. Lyon: I object to the statement in regard to the next well for the reasons we have already discussed. And I think this finding should just say that the Lovett well No. 1, Lovett No. 1 Well, of the Gypsy Oil Company producing from a limestone formation in the Ritz Pool, Kansas, was treated with inhibited acid by Dowell, for the purpose of increasing. That is the finding.

The Court: I am inclined to think in view of what Judge McDermott has said which, of course, our Sixth Circuit will read, that it might be helpful to them, and it is the only reason I think I want to reverse what I have just said. I have just indicated I don't think that Gypsy Oil treatment with the inhibitor in where they tried to dribble it down the well, and they had some theory that didn't work and didn't arrive anywhere, that doesn't have anything to do with the case. But a person that doesn't have the time to read our entire record, but reads Judge McDermott's opinion is going to be in doubt about that, and I am not sure but I think, I am glad to hear what you gentlemen say, that it might be well to say on that exact date, from so and so to so and so, the Gypsy Oil Company tried an entirely different experiment than the one suggested by the Mellon Company and went on their own initiative and tell briefly what it was, and that it didn't succeed. And then if you want to write in the next one, I don't see any relation between the two. It was true they used inhibitor, and then jump right over and say that on such a date this company treated it. Now, does the record show clearly to me what happened in between?

Mr. Lyon: Nothing, it doesn't show anything about what happened between the date of that dribble treatment and the date of this first well.

The Court: They might have made a different dribble treatment, for all I know.

Mr. Lyon: They might have done a lot of things.

The Court: I haven't any showing about it, and I didn't listen carefully or ask questions for the purpose of finding out what happened in between.

Mr. Owen: The correspondence which is in evidence and which was also in evidence in the Williams case shows that after trying the dribble treatment for the removal of gyp, some of the engineers, or Gypsy men, recommended that they try some other scale remover, commercial scale remover, and they bought some of it and tried it on one well, and then a little later they tried to remove scale by mechanical means, by putting something down the well, some mechanical tools to knock it loose. So the record does show they did that.

The Court: I say there is something they did in between. Now, if I am going into that, it seems to me—I don't always do—if Judge McDermott didn't have that in his opinion about that two years, and didn't attach importance to it, I wouldn't feel that it was necessary for me to make any reference to it, but he does, and he has, and I don't think it is important at all. You can see not only for the other reasons, when I don't know why a thing stops, I don't see how I can attribute it to some particular thing, but more than that here is a thing that did succeed and some years later Dow successfully does the same thing, namely, removing gyp in identically the same way, no different at all except that they are a better organized, better equipped business way of doing it, instead of puttering around the way men would do out in an oil field in doing a job of that kind. Now, that is the only reason I can see why one succeeded and the other failed, because so far as removing the gyp is concerned, they are done exactly alike.

Now, if that story is to be told, I think it ought to be

put in in that way, and I am of the opinion that in view of Judge McDermott's opinion, it better go in here and go in just right, put it all in there, not as to what they have testified to, but I am willing—I believe that testimony—I am willing to find that that experiment was conducted out there, and that it wasn't successful, it wasn't according to the Mellon proposition, and that the first one was successful that followed the Mellon proposition, and these other things they did, so it shows what was happening, and then the date, if you want it, that the first treatment was made of a well for them with the acid—that isn't the same kind, now.

Mr. Lyon: No.

The Court: That is one of the misfortunes that Judge McDermott was hitching—and so far as defendants are arguing, and I will say something about that later, because there is a good deal of force in that argument, that because they were putting this very inhibited acid down in there for taking the gyp off, you are getting pretty close to what the patent in suit attempts to do, I am telling you; there isn't much space left in there, we are near putting it down in there to take off gyp, but I see for the purpose of meeting that, you have got your argument that there is a difference. But I don't see then but what it ought to be known that that very gyping and their methods recommended by Mellon and followed by the gyp, is the very method followed by Dow. I think that ought to appear in here.

Mr. Owen: Well, we don't know that, Your Honor.

The Court: You don't know what?

Mr. Owen: I don't know that it is the exact method, so far as I know, both of them put inhibited acid down that well.

The Court: Of course, they did it better, and that is the reason. But so long as you are talking about failure and why they failed, there is something that is worth our thinking about, when there is a thing that goes to sleep, and the Dow revives it and does the same way and gets good results and makes a success out of it, and makes money out of that thing, while they come around with it and make

three successful efforts, but they don't care to go ahead with it.

Mr. Owen: I think we could prepare a finding along that line and I will discuss it with Mr. Lyon.

The Court: All right.

Mr. Lyon: If we cannot get together, why, we will bring it back to the court.

The Court: Well, when I was saying they were successful and when you are saying they were successful, we were both meaning for the purpose that the Mellon Institute recommended them, and for the purpose they made the experiment. They were only working to do something about that. But they went further and said, and they had a pretty good thought, that maybe, if you followed that old patent of 1896, why, maybe you will clean up the well, too, and get more production by this experiment with gyp, which was successful, which was the one that the Mellon outfit had recommended, which was for removing gyp.

Mr. Lyon: And at page 18 of his deposition, Dr. Knappen testifies the treatment of the Berryhill No. 8 was a complete success from the standpoint of well trouble.

The Court: Yes. You take it that it was unsuccessful as to removing gyp?

Mr. Owen: No.

The Court: I don't know as to the failure after that. I think Judge McDermott got the idea there was, but I can see how easy it is to get the wrong idea in the trial of this lawsuit.

Mr. Owen: Mr. Wiles reminds me that there was one of those reports which stated that the Westcott treatments were technically successful but commercially unsuccessful. That was the statement.

The Court: They had to rig the whole thing up for the first one they made, and put all their expenses in, and I will guarantee the Dow showing would be equivalent, if you charge in all of the expenses and trouble you went to to make your first step, then you would be money out all right.

Mr. Owen: That is right.

The Court: I would call that successful, now, in my honest opinion about it. The Mellon Institute was proven exactly right.

Mr. Schaffer: What disturbed me, Your Honor, is the impression I received from one of your remarks that you thought that this patent should only be tested by the inhibiting art, and not by the well acidizing art at all.

The Court: One ought not to forget that the way this acid works down in there is no different than it was before, and that all you are entitled to, and all you have accomplished, and all you claim you did, is the saving in expense and you just make it top-heavy with the argument about how much oil you make on the theory that this stopped, because it was no hot and destroyed so much pipe, that that is the reason it stopped. There is not any evidence in the record, in my judgment, that shows that as the reason. And, the whole case has been tried on that theory, and argued on that theory, and evidently everybody except the district judge out there proceeded on that theory.

Mr. Schaffer: If we were the ones to make it work successfully, aren't we entitled to that boast or that claim?

The Court: I don't know when I ever had a patent where they just jump right over the thing that was new, claimed to be new, and leave it so completely alone. You find it in pretty scattered places in this record. The new thing you did was to, according to your own claims, that was old for metal generally, according to your own claim the thing you stopped was eating metal. Now, if that did so much harm that it ruined everything, why, all right.

Mr. Schaffer: Can't we go a step farther than that?

The Court: I don't think there is anything in here that shows it is so dreadful a thing. I say it is a good thing. There isn't any doubt about it. But, to say that without it, it is so bad that a good organization like Dow, without the other, mind you, if it wasn't in existence they wouldn't be using it, I think it is a great presumption and no more true than to say they wouldn't be taking gyp off now if you hadn't made the invention which you admit doesn't have

anything to do with taking gyp off, your invention doesn't. That was old. And, yet, undoubtedly many times more wells have the gyp taken off now than did before.

Mr. Schaffer: We claim, Your Honor, that that is a point that goes our way rather than against us, because it shows how close they got to the acidizing step and still did not realize it. May I proceed, Your Honor?

The Court: Yes. And, before you do, to save your time and to start Mr. Lyon and his side thinking about it, I haven't, while I came up here last night and worked until nearly ten o'clock, I spent my time reading patents, and I haven't read the record, if it has been transcribed. I presume it has. But, I haven't read it.

I don't think the question of aggregation is involved in a chemical process. I discussed it in showing how I looked at the genius of the invention, and how I pulled it apart and tried to put it together, and talking about it as you would if it had been a machine, talking about an aggregation; but, as a matter of law and a matter of fact, I think a chemical process always must be tested on the old inventive theory as to whether or not there is ingenuity enough to give it a patent or not, and whether it is old, whether the method or process, whichever you want to call it, is old or new, and if enough new so that it required genius to make it, I don't think we do—I talked very much here about buzz-saws, and corn shellers, and things that you would make, and a hot candle. That is my way of thinking about this, only reaching the amount and degree and kind of invention that it required to make this process or method, and I am not of the opinion, and I think the record disclosed that, that I intend to dispose of this case, this patent; on whether the method and process is new and enough new to reward it with a patent or not. And, I don't expect to approach it, and I think I have said that, only we were talking about the other. I think I said and I intended to say, and I now say, that I don't think when you are talking about something made with chemical elements or a process for using it, and a method for using it, that you apply this principle of aggregation. It just doesn't fit.—

And, all I meant by the numerous illustrations and visits we had was to try and test out how much of novelty there was, if any, and if there was some, how much effort it took to develop them.

Maybe Mr. Lyon differs with that theory, but I don't think there is any question of aggregation. I notice now that my friend, my distinguished friend, Judge McDermott, gives a portion to that and discusses it, but I imagine he thought of it and he seemed to have discussed that phase of it much as I was discussing it, only reaching the opposite conclusion about it, I don't think he thought that aggregation applied to this kind of a patent, even though he gave that sort of a heading to it, and I don't think,—I don't know of any case that says a chemical patent for a process or for a method is bad because it is an aggregation of something. When you go to thinking only about aggregation, I just can't apply it to a chemical patent, and I don't think any court ever has.

Mr. Lyon: I haven't asked for any findings, I haven't requested any findings on the aggregation feature because I think that is too debatable. I can conceive that there might be a case where chemical things might not be truly related and be claimed when they are nothing more than an aggregation, but I haven't proposed any in this case. I have treated my findings, as Your Honor will see, on the question of invention, testing it in the orthodox fashion and not asking the court to rule that this is an unpatentable thing because it is a technical aggregation.

The Court: Then I don't need to spend any time on that. We are down to the one thing, the thing we are to decide is simple to get at but not so simple and easy to decide, but it is a question of whether or not there was invention in this method described.

Mr. Schaffer: Well, Your Honor, I think that it probably would be well for me to defer the more detailed discussion of the authorities that I have in mind. I think there is one question, and it can be briefly discussed, that we would like to bring more clearly to Your Honor's attention

at the present time, and that is the bearing that such findings as long-felt want and success might have or would have on the case as we view it.

The Court: When you talk about a wonderful growth of a thing you have got to do some studying to know why, and a good share of what you have got is because I kept talking about that, and there is a lot more I should have talked about.

Mr. Wiles: Perhaps so.

The Court: To see how that thing did go, and just why. And I have never known of a case that leans so heavily just on that one thing myself as right here.

Mr. Wiles: I didn't think, Judge, that you had ever—most judges never do have a case that falls into this narrow groove.

The Court: I very seldom have one that don't urge it. They urged it,—

Mr. Lyon: In the Balloon Tire case.

The Court: Yes, the Balloon Tire case; they urged it in this Ventilator case not very long ago, the Chrysler I refer to, that was their big thing there, how it had grown, but I looked through to see why it had grown, and in these days of big business there is a very different situation than when we had a lot of little fellows scattered around. This thing you have been talking about has been getting more dangerous for judges to be influenced by, unless they are very careful and if you will notice in this record, I began very early to suggest that thought that I wanted something to know why it grew, because I early reached the conclusion that you now say is right, that that was the thing you were relying on.

Mr. Wiles: Wholly.

The Court: And I have been saying that is the thing that Judge McDermott put it on, and I thought you were disputing me on it, but now I wish I could have known at the beginning of this case that you conceded that that was what—without it your decision would have been the other way.

Mr. Wiles: Oh, certainly.

The Court: In the Tenth Circuit, and without it the decision should have been this way. I would have been thinking and rivetting my attention to that, and thinking of more things I had been asking for to have you produce information than a little. But, my attention has been scattered, and I think you will see the record is, relative to this patent, to a very wide range of things.

Mr. Owen: This point hasn't been discussed at all, and I would like to just mention it, that no matter how narrow Your Honor may consider the Grebe step to have been, and if you confine it to the placing of the inhibitor in the acid, why, then, with that construction of the claims we get a rather narrow protection at the present time, because it does appear that due to modern equipment, high powered pumps, and enabling the introduction of the acid into the well quickly, that it is not necessary to inhibit it as highly as it was with the old equipment, and it may be that in open formations they can get by without any inhibitor at all.

All we are asking in this case is that the defendant use what they claim is being used by the Chemical Process Company, and if they will do that we are perfectly content to let them go on their way and compete with them just as much as we can, but we do say we are entitled to what little protection, what little benefit may be derived from the use of the inhibitor.

The Court: Of course what I want to do is to find your facts without reference to the law, without reference to where it leads, but as you can see my notion seems so in conflict with your views, and really to be fair about it, so contrary to the views of the Court of Appeals, results from my thinking differently about the facts than you do and the Court of Appeals, very largely, now.

I think Judge McDermott applied the right test in that case, as near as you can get at it. He didn't say some things that looked to me as if he was—I don't reach the conclusion that he didn't consider at all the difference and put it between your patent and the Frasch patent. It is plain that

he did, and he reached the conclusion there was enough, but he did make great use of—almost seemed—the development in the art, the success, and I don't want to be understood as criticizing Judge McDermott. I do reach a different conclusion as to the facts. When he says the gyp was a failure, I don't think it was. When he says the Frasch patent, when they applied it, that it was a failure, and his testimony wasn't so complete probably as mine, I reach a different conclusion so my findings of fact now are necessarily going to be different.

You see, if I am going to follow Judge McDermott's opinion, all I have got to do is to follow it. And the result is clean for me. That was the easy way out for me, and I wish it could have. That would make such an easy thing for me to do. I get back to this thing: Frasch was not attaching big importance now to how to get it down. He is just going far enough to show you what he could do, as he looked at it. He did not even bother to claim it, and I agree to all you said about claiming and all that, but it just goes to show that Frasch was not greatly concerned, he isn't claiming he discovered anything new about how you put it down or anything of that kind.

He is looking at his discovery, to the big thing he did, and the only big thing he did was to discover that that acid would eat away the rock and that you could press it back, by pressure, and it is when it had eaten the rock, it was in solution, and you could fetch it out. That is the big thing that Frasch did. And he did not attach enough importance to those other things, so he thought he could get any patent on them, and I doubt, he probably could have put it in the process, but I don't think you could have added much, as I look at it. I think that is one thing to bear in mind on this whole case, that he did not consider that of a mighty lot of importance. If he had, he would have tried to make a claim that would cover it in some way. Isn't that logical?

I am going to say before I am through with this case I don't think there is any difference from an inventive standpoint between Frasch and Grebe and Sanford, except the

inhibitor. Now, that is my honest opinion and I am going to say that and stand back of that, and it would be perfectly right for anybody in the world to disagree with me, but that is what I think and that is what I am going to say.

Mr. Wiles: I shouldn't object at all, when you say "from an inventive standpoint."

The Court: I said that over and over, but I think it is idle for me to tell the Court of Appeals what Grebe and Sanford said, they had better read it and find out than for me to try to tell them my opinion. I am saying right now, if you prepare an opinion for me, to put in that I don't think there is any difference between the two, and I am talking now not about the color of the print they used when they printed it, or whether it was coarse type or fine type, I am talking about the standpoint of invention, that I cannot find one single thing in Grebe and Sanford that I don't find in Frasch, except your inhibitor. Now, that is my opinion and I want to say that, and I am not going to say any different than that. That is what I think and what I want to say. Now, I don't care whether it is, and I think it is more properly the way I am saying it now, in the way of a conclusion of law, I think maybe that comes closer to a conclusion of law, but I do think it is wrong for me to take these patents and go through them and make a finding of fact as to what they mean. That goes for the exhibits and it goes back to what I was saying before. I don't think it is my premise.

Mr. Owen: Then I suggest, Your Honor, that no finding be made for either party as to what the Frasch patent shows.

The Court: All right, but that is a conclusion of law, and I have already stated it on the record, so you have got that in.

Mr. Owen: (Reading): 26:

"Prior to 1932, there was no teaching that an oil well producing from a limestone formation could be treated with hydrochloric acid to which had been added an agent to reduce the corrosion of the metal equipment of the well by acid."

Mr. Lyon: Outside of the Frasch disclosure, a general statement that other methods of protection could be used—we don't claim that anybody had actually used an inhibitor in treating limestone. The Gypsy came pretty close to it. I mean limestone formation, when they used an inhibitor in treating limestone scale to protect the pipe upon which they passed the acid. But, I think this finding is worded to catch a reader who is not on his guard, I can see that, and yet I don't claim that there was any use of an inhibitor other than what I have stated.

Mr. Owen: Well, this states very clearly the fact.

Mr. Lyon: I am not sure how clear it is.

The Court: How about the teaching. Is it an unsuccessful experiment so far as it took that gyp out of the well down in there, but somebody may say that that thought—it seems to me it would teach anybody, if it had been limestone formation they could have used it. But I don't claim it is an experiment, and I don't think teachings undisclosed are evidence against you. It isn't a public document. It was a private document, as I remember. Isn't that right?

Mr. Owen: That is right, Your Honor.

The Court: But I think you could draw the conclusion that—I will deny that.

Mr. Owen: Well, I don't like to argue a point after Your Honor has reached a conclusion, but it does seem to me that this is rather important for the plaintiff.

Mr. Lyon: Why isn't the next finding just as good, Mr. Owen, if we can agree on it. If we can—if we can okay that one, why isn't that one just as good for your purpose?

Mr. Owen: They are two different things.

Mr. Lyon: I thought they were pretty much the same.

Mr. Owen: No, the first one, 26, is directed to the teachings of the prior art, and there was no teaching of the prior art that this process could be carried on. The only teaching—the only thing that might possibly be a teaching was what was in the paper.

The Court: If somebody taught it and hadn't put it into practice, you could say it wasn't any good. Now, why

have me say something they did not do, that isn't material. I am not sure whether that teaches—it sounds pretty near as if whatever they said about gyp, telling if they got any gyp down in the rock, was sand and was not lime, that they could probably eat it off with this. Well, if it had been lime, they pretty near tell them they could eat it off, but because they taught them that, it did not teach them in a publication. And did not reduce it to practice. They can't use it against you here. But there it is for me to negative the fact that it taught—

Mr. Lyon: (Interposing): It certainly taught one important element, and that is that you could put an inhibitor in an acid and protect the pipe while the acid was going down the pipe. It certainly taught that.

Mr. Owen: But it certainly did not teach the engineers and officers of the Gypsy Oil Company that they could—

Mr. Lyon: How do we know?

Mr. Owen: Because they didn't do it.

The Court: That is, the word "learn" goes in there instead of the word "teaching."

Mr. Owen: Well, I read Your Honor here a few days ago a letter that the officers—to the officers—or the production manager, it was, of Gypsy Oil Company, wrote to Dow when we started in acidizing wells, and they were anxious to know when we could acidize a well for them out in Kansas, and that letter was written in January. That letter was written in January—where is that—1933, and the first well that was acidized for the Gypsy Oil Company was in February, 1933, by us, as a result of that letter.

Now, in 1928, Westcott made his report to the Gypsy Oil Company, and they treated two or three wells according to his recommendation, and that did not teach any of the officers or production men of the Gypsy Oil Company that they could do that same thing in limestone.

The Court: I am going to let that stand denied. I don't think I need to make a finding of that kind, about what was taught.

Mr. Owen: Then the next one: "The plaintiff, in 1932,

was the first to treat the producing formation of a limestone well with inhibited hydrochloric acid charged into the well through the pump tube."

The Court: Given.

The Court: If he had my case right here, I think Judge McDermott would have reached a different conclusion on validity. In fairness to Judge McDermott, he has intimated as strongly as I ever heard a judge that it was right on the bare point just in his re-hearing, and he again emphasizes that, and I am convinced that if he had this record I have, with all these different things that have been brought into it, that weren't there, more thoroughly and more completely, I think he wouldn't have thought, if he had this record here, I don't think he would think that the gyp was a failure for gyp, and I don't think he would think that those experiments down in Ohio were failures, and I don't think he would think that the Mellon Institute recommended something. Of course, he did have that before him on the re-hearing.

Mr. Owen: He corrected that and he did not have before him any evidence that this Fraseh patent ever went into use. So that he made no mistake on that.

The Court: That isn't very important, but that is what I think about it just the same. And our own good court and three judges instead of one are going to be able to talk that over and think about it, and they aren't going to follow me about that, but I am giving them the benefit of my opinion about that, and I think it is fair to Judge McDermott too for me to be able to say that, when I reach a different conclusion than he did. It goes way beyond my taking his record.

I will say in addition to that, I am equally frank to say on this record that I think on his record I would have decided as I here decide, but I think there is a decided difference in the two, more complete, and in a close case, as he recognized it was by expressive statements, why, I think it is enough to have tipped it the other way. So I will let that stand.

I don't think it is a finding of fact. I don't state that. But it is true. I don't think that is a finding of fact. It is more a finding of how my mind worked, and it is measuring up to voluminous records, so I don't want our Court of Appeals to be—and they will, they will know what I am doing, that there is a long record over there, that I haven't read all of it, but as this testimony came in I looked back there and I have learned in different ways as to what was there, and what was here, at different times, so I have had a chance to get into that and I think I ought to express myself. I don't consider it as a finding of fact, though, by any means a very proper finding of fact, but I am willing to express myself on the subject.

I am of the opinion that oil wells can be acidized successfully without an inhibitor. You take this off the market. It has been sort of a thing now that doesn't do the least bit of harm, and you put it in because it doesn't do any harm, but I think it has been over-emphasized in this case all the way through, the impossibility of doing that without the inhibitor. It is far from being impossible to do it, and if there was some way you could think of taking the inhibitor off and going ahead and acidizing wells this business would not stop.

Now, that is another test in connection with what it has done to it. I am just as convinced as I can be if you take the inhibitor off they wouldn't stop acidizing wells. It would go right on today in my judgment now.

Mr. Wiles: Judge, I wonder if I might ask a question. We have, as I understand it, conclusions of law to draw, and that will, to some extent, take the place of a formal opinion. As I understand, Grebe and Sanford, you say, is bad for want of invention, and that is the ground of invalidity. That is the acidizing process.

The Court: That is right.

Mr. Wiles: The same is true of Gravell; Gravell is bad for want of invention.

The Court: Yes. I haven't put it just in this way because we have been talking about separate patents, but

to my mind, that first one, Gravell, and Grebe-Sanford in a similar class in this respect,—there are many other things to be said, but I think of, first, somebody is thinking of an inhibitor, and they began by making inhibitors, and, oh, there are so many inhibitors. There is the metallic inhibitors, and there is the organic inhibitors, and there is the combination of them, and, oh, so many different combinations that could be made for an inhibitor, that it is almost a problem for a great mathematician to tell how many combinations you could work out.

It did grow, that inhibitor business, it grew and they improved it as they thought of new things, and they got to simmering down to the best of them, and the best combinations, and all those things, and it is hitched in there in a way with the plating art, kind of grows out of that because, I believe, my final conclusion out of inhibiting, is that it does put a film on the thing that it is going to protect, similar to plating, only the film that gets on there isn't permanent, and we don't think of it as that in the regular,—what we have come to call the inhibitor.

It is a flopping or looser, less permanent sort of a thing, but its method of getting there is very similar to that, and the plating art was very helpful, if you can call them separate arts, the plating art and the inhibiting art, they are right in the same field, they are dealing with the same sort of things and the same sort of principles and the electrical part of it is so similar. They run along together, and as the years pass that is getting better known until when it got down to the time of Gravell you had to do something pretty outstanding, in my judgment, in order to get a good patent, something outstanding with all the things that had been taught. If you want to do some particular thing, and you want to put it on fast or slow or permanent or temporary, or store it here and have it stay for a longer time, or for a short time—there are so many combinations and so many uses, and yet the general story about inhibitors was mighty well known when it came to the day of Gravell.

And, while maybe you can find some new combination

growing out of it, the main thing he was thinking about was using this old principle of an inhibitor in a particular spot, namely, when you stored it in iron drums or containers.

Now, I think that the art had advanced too far, and that the inhibitor was too well known for him to get a good patent on that particular use of it. Of course if he had started way back in the early days and had discovered an inhibitor, and had not gone as broad as he wanted to, limited himself to drums and containers, we would have protected him in what he claimed out of the larger field that he might have, but I think he lived too late and worked too late and invented too late and got his patent too late to be allowed a patent because he thought of drums and containers.

I think it got to such a state that wherever you wanted to inhibit iron, whether you were working in the factory or out in the field or this state or that state, or even in one art or another art, that it wasn't invention in my judgment to apply that to steel drums and containers.

You see, I am leaving out of that thought now the new combination that he claims to have got, putting arsenic into the acid regulator, or what could be called an organic base.

I know that the claim is there, but I say I think that they made so many different combinations that it is just going to be too bad for business. I think of an invention, that we ought to treat in the courts these patents in such a way that it can carry out the real purpose of the patent law, which was that it should help business and help the world by bringing them something new that is going to be useful, and we are going to award the individual that produces that sort of thing by a monopoly for seventeen years, and then when the people are going to get the advantage of that thing for the world thereafter. That is just a bargain you make with him, and we ought to look to a patent and see whether or not it is working that out and accomplishing that.

Now, I think Gravell's patent would work just the op-

posite way. I think that somebody some day, when they really badly wanted a container and they found the iron was eating up, they would say, "Well, we will put in one of these inhibitors," which was always in existence; that is what I think would happen, and I don't think you can reward him with that patent, and if you did see the misfortune it is going to be to business.

It prevents the world from using the invention of the inhibitor so that it will not eat iron and steel.

Instead of it accomplishing the thing I think that the patent is for, I think it would work just the other way for that patent to be good.

Now, we come right along a few years and we run right into Grebe and Sanford. Now, we have got this old inhibitor thoroughly investigated made new by Gravell, but many others, it is well known about the inhibitor, but it will stop anywhere in the world so far as I know, I don't think there is a time when you take hydrochloric acid and you put these inhibitors in that it don't help and check the eating of that iron. Of course it isn't as specific, it doesn't do it a hundred per cent, but it checks it and that was well known and everybody knows that.

Now, along come Grebe and Sanford and they just make use of that old thing. And all I have said about Gravell using an inhibitor of some particular kind applies to Grebe and Sanford using an inhibitor. And any place. I think it got too late. Unless it would have been a very unusual thing. I don't find anything unusual about the use Grebe and Sanford made of it. I don't see any more novelty, any more difficulty, any more ingenuity with the acid eating the pipe if they wanted to acidize the well and the acid was eating their pipe. I don't see how that could stand in the way any more than the thought I have of its stopping eating the tank or container. And here, so far as the acid is concerned, they say it is eating the rock and then they go back and bring the other in and bring the two together.

In 1896 they had a patent on the eating of the rock

with hydrochloric acid. I don't see anything new. I see a little change in the perfection and all that, but all I can see was invented was just like I say Gravell put something into a tank so it wouldn't eat his tank, and they want to acidize their wells according to the principles of 1896; they just put some of this inhibitor in there. There isn't anything unusual about the inhibitor. Isn't anything unusual about the acid. I can't conceive of anybody having any pipe, worrying much at that stage.

Of course inhibitors have been known now since 1896. They have become better known, different combinations, and so on. Many of them. They found metals that were better inhibitors and developed them and the combinations. You could buy inhibitors as you could a 5c cigar, and that's the way it is, it seems to me. You get a man who wanted to buy hydrochloric acid for this particular purpose it seems to me could be sold in a twinkling of an eye.

It seems to me those two patents fall in the same type. Again, thinking about the purpose of the Patent Office, there we have the purpose to develop an art—not to strangle it; to develop business—not to strangle business. And we had that in 1896, knew how the acid could eat in the well. There was a basic point. It might be old for hydrochloric acid to eat lime. There was a new use; a new place that you can see; that that was knew and worth while. It would have been a pleasure to get a patent like that and enforce it and make people pay tribute to it for seventeen yars. But the time has run on that. That belongs to the people. The principles are no different.

You have a patent there that just runs crosswise against the grains, like the tank does; it is putting it in a different place, but to do the very thing—to inhibit it from eating iron and see what it does. I don't know of a better example of patents strangulating business instead of patents helping business than you have here. We have a Patent Office putting us in this place wherein they gave the right to have the hydrochloric acid eat the rock in the ground, and then in many patents they have given the right and the protection

to inhibit acid so it will not eat iron. And then they start in, as usual in these arts, to run crosswise, to make new combinations, first, of everything they can do—maybe eat the iron a little bit better, this and that, and then they start crosswise of it. That is common in these arts.

And here is a patent if you use this inhibitor and acid in a storage tank to transport it or store it, and here is the other patent to put it down in a well past a tubing, now you can say many of those patents that I have been talking about have run out. But I think of them as not having run out. I think of them as being transferred at the end of seventeen years, and the man who has gotten the patent over to the public. The public use is just as sacred after seventeen years has run as the patentee's privilege or monopoly was during the seventeen years he owned it.

This is the thought I have where they put business, the Patent Office, by this sort of a granting of a patent. They put Halliburton Company in the position, if their patent is held good, where they could haul the acid in an iron tank, save that money and get up to the well where it begins; and then Halliburton is through. They can't go any further towards using that Frasch patent of 1896. So they are interrupted in business.

Let us go over to the Dow. How are they situated? They have to either not use this kind of an inhibitor but they can't haul the acid they want to inhibit if the Gravell patent is good, down there in an iron tank with the arsenic in it and the kind of inhibitor—any kind of an inhibitor they want to. They have to go to the laboratory and try to figure out some sort of thing to get around the Gravell patent or else get a wooden tank—in those days it was more convenient than a steel tank, it was cheaper to get it, more convenient in every way. They can't haul their acid down in a steel tank, but they have to get to the well. And they have to get around Gravell in some way, get it down there.

Now, if that isn't strangling business and doing harm and forcing two fine concerns to get into a row, snoop on each other in business, doing a lot of things they don't want

to do, if those two patents haven't interfered in business, then I don't know my business. These two patents have stood in the way of progress, they have stood in the way of business. It would have been better for the public served, it would have been better for Dow and better for Halliburton, and better for the world if these two patents had never been granted, in my opinion. The cost of it! I can't feel but they worked out just the opposite of the aim of the Patent Office that encourages the development of things for the betterment of the world. I think they had just an opposite result, and the granting of this sort of patents results in that sort of thing. I think we ought to be very, very careful about that.

So, that is in a general rough way now, some of the things, and you can imagine these six weeks I have been making notes here, if I had hung them up and would say all the bad things I have thought of about these patents from the time this suit began down to today, I would keep you here altogether too long, because they are just open to a lot of things.

You can test them out in all these ways. For example, some of the claims of the Grebe-Sanford patent are such that taking them, and, of course, if it was a good patent I readily agree if it was a broad patent like the 96 patent, I would readily find a way of saving it, but just read some of those claims. They are so broad that if Halliburton brought their acid inhibited down to the tank, down to the well in their iron tank, or in any other way that you inhibit it and put it into the well just exactly as Frasch said, the claims will read on it, some of them; of course that is just maybe an over-stepping, but that shows how broad some of those claims are.

And, I don't think it should be measured by that. You say the Grebe-Sanford patent, they talk about that just as if there wasn't any Frasch patent. In order to see Grebe and Sanford at all, you have to just wipe Frasch off from the map and say, "Well, he got a patent, but it wasn't any good and he couldn't do anything." Grebe and Sanford are entitled to just as much credit as if Frasch didn't exist.

Well, that is entirely wrong. The measure of what Grebe and Sanford tried to do, the way they got past the Patent Office, was the measure of not eating the iron, and therefore the measure of its value, if it had one, if it didn't have an inhibitor, the measure of it would be "How much iron did it save and how much acid did it save?" That would be the measure of the benefit of it there. But, I approach it not from that trouble, but from the amount of ingenuity, as I have already said, and here is another thought; I don't know how much I emphasized it, but you take this patent, we get around to where we practically all agree that there is nothing in the world that saves it unless we can say it has had this wonderful success and done wonders for the art. That is what saved it in the Tenth Circuit.

Now, that is a thing that I think this should be emphasized about: The burden of proof is on the owner of the patent to show that sort of thing, surely. And surely if we are going to in the courts be practical now, and reach the right result, we are not going to be satisfied because we see a curve of business, and using after that, we are going to say that it is due to the patent. I say that the burden rests on the plaintiff to eliminate other things that we know make curves of business go up. The world is full of successes and full of failures, and the curve doesn't go down always and men fail because of a patent, and it doesn't always go up to success because of a patent.

Why, the number of things that enter into that are so many that if courts are going to accept a record that just shows an up-going curve and say, "See the wonders that patent is doing," and are going to take a patent that would be held invalid except for that, why, what a dangerous field we are treading on. It just is going to upset the Patent Office, is going to lead it and put it into the hands of big concerns that we want to prosper and be thought well of, and I for one admire those who can succeed, but it is going to work back on the big concern, and it is going to give a monopoly of the patent, a monopoly that is not due, because they are large and capable to take a thing and do

good things with it. You can go and find old patents in the art, undoubtedly, that have run out, and the fellow that has got them—I have seen many of them; nobody picked them up.

If business should take one of those, and prosper with that patent what otherwise wouldn't be patentable, the art is old and the patent is on it so that it is old, but just take a big fine concern with lots of ability, it takes that up and makes it move, I think in all patent cases where that is going to be claimed, that something is to be given to the success of the thing, that the burden should be on the plaintiff urging that, the owner of the patent, to eliminate the other things, so that the court could feel that it is due to the patent.

That is the reason I began early to inquire about those things. And this is a limited field, it isn't as large as some patent medicine case or breakfast food, or some of those things, but we have to again think of the kind of business we are dealing with. Why, a $20,000 ad in the Ladies' Home Journal wouldn't be worth much to Dow. Just in this field is the only place we want it.

We haven't gone into that to show what they are, but if I was going to make findings on those things, I would want to follow this further. If we are going to grant a patent, and that is the only thing, I am going to give it my attention to know how much it is going to cost. Naturally, it is different from selling shoes, or patent medicine, you have to reach everybody, or something of that kind. Here is something that is a limited field. I would want to not only know that, how much it would cost—if I was going to allow this patent on that ground alone, a patent that was applied for earlier, certainly with the passing of years it got easier because inhibitors got better. So, it was easier later than at the time it was granted. It was easier than it was when the inhibitors weren't so well known, and so thoroughly developed, and so easily acquired, and so much talked about. But, if I was going to do that, I would want to know how much it would cost to thoroughly cover that

field. If I am going to grant a patent that would have been, under other circumstances, more difficult to invent, because there wasn't so much known about inhibitors, by going back there and saying I am going to save it because of the developments, then I would want to know how much it cost to thoroughly cover that field where it would do any good, because it wouldn't do any good to advertise it in the town of Leslie. You have to go over to where they are. And, I take it it is a very cheap medium of advertising that you could reach through the grapevine method. I can't think of any product that would be easier to reach the consumer than this, because you have limited fields and know right where it is.

And then we go over to men. I don't think the number ought to control entirely. If I was going to say that I would want to get down into how good the men were, what they did, and what price men they were. Their numbers don't count so much as their price. And, I am just guessing, and it is all right to guess, because the burden of proof is on the plaintiff,—I just imagine that the men selling this stuff are a mighty sight higher paid men than the ones driving the trucks and taking care of the acid. I don't know how that would show as to how much money this concern has spent from beginning to end to get business as compared to how much has been spent making the acid and putting it down the well, but I was just showing, really, the danger in a patent of this kind, that you can see right on the face of it ordinarily, the ordinary individual that thinks about it, that there isn't ingenuity enough to make a patent, but you are going to save them, because of this business.

Why, if I am going to save a patent on that ground, I certainly want to analyze all of the things that tell me so I feel certain that they were due to that patent. I think that must be done, because we are going to go along with a lot of patents in these days of big amounts of sales by any concern that is big and has a product that they can sell. It is very difficult to measure what Dow, with the same effort

put back of this, could have done without an inhibitor, if there hadn't been an inhibitor known. But, as I see it, I don't think there is any proof here of somebody finding that it was so harmful that they stopped. I don't think it is that kind of a case. I am satisfied the same amount of effort to make this well go with the acid uninhibited, wouldn't have done so well, because it would have eaten up some pipe. There isn't any question about that. I am not taking that away from the patent. I don't feel that way about it at all. I think the inhibitor is a fine thing and ought to be used. It is used, and legitimately used, legitimately advertised. It isn't so complete as claimed for it, but enough so that it doesn't do harm to the pipes, and that is what they want.

Well, that is some of the thoughts running through my mind, and I say I have many, many more. I will be thinking of them all night, and the next two or three weeks until I get tied up in that next case down there, and then I will forget all about this case thinking about that.

But, I have been thinking of this all the way through, and you can see my thoughts have all been leading me to think for this reason and that reason, that all three of these patents, it was unfortunate, that they shouldn't have been granted, and the business would have been better without them. It will be better without them. I think everybody will be better without them.

FINDINGS OF FACT

1. This is a civil action arising under the Patent Laws of the United States.

2. Plaintiff, The Dow Chemical Company, is a corporation created and existing under the laws of the State of Michigan, and has its principal place of business at Midland, within the Eastern District of Michigan, Northern Division.

3. Dowell Incorporated is a wholly owned subsidiary of plaintiff, The Dow Chemical Company, engaged in the business of acidizing oil wells within the Eastern District of Michigan, Northern Division, and elsewhere in the United States.

4. Defendant, Halliburton Oil Well Cementing Company, is a corporation created and existing under the laws of the State of Delaware, with a principal place of business at Duncan, Oklahoma, and a regular and established place of business at Mt. Pleasant, Isabella County, Michigan, within the Eastern District of Michigan, Northern Division.

5. Plaintiff is the owner of United States Letters Patent 1,877,504, granted September 13, 1932, and charges that the defendant has infringed claims 1, 5, 7, 8 and 9 of said letters patent, within the Eastern District of Michigan, Northern Division, and elsewhere within the United States.

6. Plaintiff is the owner of United States Letters Patent, 2,024,718 granted December 17, 1935, and charges defendant with infringing claims 1, 2, 3, 6, 7 and 8 of said Letters Patent, within the Eastern District of Michigan, Northern Division, and elsewhere within the United States.

7. Defendant is the owner of United States Letters Patent 1,678,775, granted July 31, 1928, and charges the plaintiff, through its wholly owned subsidiary, Dowell, Inc., with infringing claims 1, 3 and 6 of said Letters Patent.

8. Defendant denies infringement of Letters Patent 1,877,504, and Letters Patent 2,024,718, and asserts that both of said Letters Patent are invalid as to the claims thereof in issue.

9. Plaintiff denies infringement of Letters Patent 1,678,775, and asserts that said Letters Patent are invalid as to all claims thereof.

10. Plaintiff has charged the defendant with infringing United States Letters Patent 1,916,122, granted June 27, 1933, and Letters Patent 1,998,756, granted April 23, 1935, but the parties have stipulated as to the provisions of the judgment or decree to be entered in this cause with respect to said two Letters Patent, and the court has been relieved of deciding any issues relative thereto.

PATENT 1,678,775

11. Letters Patent 1,678,775 are directed to the storage and transportation of acid solutions such as attack steel in steel or iron containers or drums instead of glass or specially lined containers.

12. The acid solutions which may be so stored and transported in steel or iron containers in accordance with the invention are identified in the patent as follows:

"Although the invention applies to acid solutions generally, it is particularly useful in connection with solutions of sulphuric, hydrochloric and phosphoric acids."

13. The patent is predicated upon an alleged discovery stated to have been made by the inventor as follows:

"The invention is based on the discovery that acid solutions containing certain metals with or without so-called pickle control substances or acid regulators, when brought into contact with steel and iron, automatically form or deposit a protective coating on the inner surface of the container which acts to prevent the acid solution from attacking the container."

14. The metals which may be so employed are identified in the patent as follows:

"The metals which have that property are below iron and above mercury in the electromotive scale. Under certain conditions tin produces good commercial results. However, arsenic in most cases is more satisfactory."

15. The pickle control substances or acid regulators which may be employed, are identified in the patent as follows:

"Examples of pickle control substances or acid regulators are crude anthracene, sulphite lye residues from the production of naphthalene, acid resins, waste acids from refining hydrocarbons, residues from the distillation of organic compounds, cyanides, liquid obtained from boiling bran and other starchy materials in water, sodium bisulphate, hydrocarbon tars, alcohols such as methyl, ethyl, propyl, amyl, butyl, etc., higher alcohols including glycerine, cellulose pulp waste, sumac leaves, gelatine, remains from the distillation of anthracene, distillates from gelatine by itself or with fats, organic bases, and aldehydes.

"The distillate from gelatine and fat consisting of various materials including organic bases such as pyridine bases and the like, produces excellent results and therefore will be selected in this description as a typical acid regulator or pickle control although other controls or regulators may be substituted."

16. The ability of many metals, including tin and arsenic, when added to acid solutions, to automatically form or deposit a protective coating on iron or steel was known in the art prior to Letters Patent 1,678,775.

17. Metals having this ability, including tin and arsenic, were known, prior to Letters Patent 1,678,775, to inhibit or reduce the rate of corrosion of iron or steel by some acids, including hydrochloric acid and dilute sulphuric acid.

18. Many and most of the pickle control substances or acid regulators mentioned in the patent were known and commonly used in pickling baths and plating solutions prior to Letters Patent 1,678,775.

19. Prior to Letters Patent 1,678,775, acid solutions, such as hydrochloric acid and dilute sulphuric acid which actively attack steel, had not been stored or transported in steel or iron containers or drums.

20. Gravell, in Letters Patent 1,678,775, was the first to disclose that by the addition of known inhibitors capable

of precipitating a protective coating on steel, such corrosive acid solutions which actively attack steel could be successfully stored or transported in steel or iron containers or drums.

21. The discovery of Gravell has been employed successfully on a large commercial scale under Letters Patent 1,678,775.

22. The prior art does not disclose the composition of matter specifically described and claimed in Claims 3 and 6 of Letters Patent 1,678,775 comprising an admixture of arsenic compound and an acid regulator.

26. In November, 1936, defendant opened negotiations with American Chemical Paint Company for a license under the patent. These negotiations eventuated in an agreement dated February 8, 1939, whereby American Chemical Paint Company agreed to assign the patent to defendant, Halliburton, for the sum of $1,000 in cash, and an agreement to give back to American Chemical Paint Company a paid-up license and to pay it a royalty of 75c a gallon on all inhibitors made or sold under the patent by defendant or its licensees. The patent was assigned to defendant by an instrument dated February 10, 1939, four months and four days before this suit was brought by plaintiff against defendant.

27. At least since 1923 American Chemical Paint Company has been continuously a manufacturer of inhibitors and other products of acid character which were originally shipped in wood or glass containers. Since the time of the Gravell invention some of its products (Deoxidyne, Deoxylyte and some Rodines), have been shipped in steel containers. Others of its products (Murodine, Chlorodine, Scalene, and some Rodines), however, have been shipped in wood or glass containers. It has not shipped hydrochloric acid, inhibited according to the patent, in steel containers, but some of its products which have been shipped in steel containers are inhibitor concentrates which contain a substaatial percentage of hydrochloric acid.

29. Not all of the metals "below iron and above mer-

cury" are effective in protecting a steel surface from attack by acid. For example, nickel and cobalt are not effective.

30. Many of the materials called in the patent "acid regulators" were known in the prior art as inhibitors for pickling acids, and defendant makes no claim that the patentee discovered their use for the purpose and admits that the acid regulators mentioned in the patent were copied from the prior art.

31. When an operative metal or metal compound of the class defined by the patent is dissolved in an acid, and the acid is brought in contact with an iron surface, as of a steel container, the dissolved metal in the acid is precipitated on the iron surface to form a protective coating or film which acts to prevent attack by the acid. This action is contact plating by immersion without an external electric current. The prior art shows the contact plating of iron and steel in acid solutions of many of patentee's (Gravell's) metal, e.g. tin, arsenic, antimony, bismuth, copper. The prior art also shows the contact plating of iron with antimony and bismuth from acid solutions containing also an aldehyde, one of the acid regulators of the (Gravell) patent (Watts, 1919) and the contact plating of iron with an acid solution of copper containing alcohol, another of Gravell's acid regulators (Iron Age, 1874).

32. Electroplating of metals is similar to contact plating, except that the former makes use of an external electric current. The chemical action in either case is the same. It was known in the prior art to add to electroplating solutions of a metal dissolved in the same, organic agents, described as acid regulators in the patent, such as glue, gelatin, glycerine and many others. These electroplating baths contain an acid corrosive to iron and steel, an acid regulator, and a metal within the range specified by the Gravell patent, and were used to deposit a protective coating of metal on iron.

35. In many cases iron and mercury reduce the corrosive action of acids on iron or steel to as great an extent as do some metals which lie between iron and mercury in the electromotive series.

36. In many cases the metals lying between iron and mercury in the electromotive series accelerate the corrosive action of acids on iron and steel.

37. In many cases various combinations of a metal lying between iron and mercury in the electromotive series and one of the pickle control substances named in the Gravell patent, when placed in an acid solution, make the same more corrosive to iron and steel than the raw acid, and in many other cases such combinations make the solution more corrosive to iron and steel than it would be without the presence of the metal.

38. Arsenic generally is the best of all the inhibitors for hydrochloric acid, and yet the addition of arsenic to hydrochloric acid in some instances, with small amounts of arsenic in high concentrations of hydrochloric acid, makes the solution a little more corrosive than is the raw acid alone.

39. In some cases steel containers of hydrochloric acid, plus arsenic and an acid regulator (sodium bisulfate, sodium cyanide or rosin), failed more quickly than did others containing the raw acid alone.

40. In some cases drums containing a solution of arsenic, sulphuric acid and organic bases failed more quickly than did similar drums containing sulphuric acid and organic bases without the arsenic.

41. In the one test of a 55-gallon drum containing arsenic and hydrochloric acid the drum failed more quickly than did a similar drum containing the raw acid alone.

42. Hydrochloric acid is generally manufactured and sold in strengths of 18° Baume, 20° Baume and 22° Baume acid and in such strengths is one of the most corrosive of the acids to iron and steel.

43. The Interstate Commerce Rules governing the shipment of acids in interstate commerce do not permit the shipment of inhibited hydrochloric acid of any strength in unlined steel drums or containers. On the contrary, they require all hydrochloric acids to be shipped in glass or earthenware jars or in rubber lined drums, barrels or tank cars.

44. Sulphuric and phosphoric acids containing the exact proportions of arsenic and an acid regulator specified in the Gravell patent (page 2, lines 61 to 63 and lines 24 to 27) when placed in I. C. C. returnable drums sealed for shipment caused failure in from 2 to 12 days. The patent gives no specific example of an inhibited hydrochloric acid but does mention a solution containing inhibitors and 75% hydrochloric acid.

47. The process and composition claimed by Gravell were developed to meet a specific problem incident to the storage and shipment of some of the products manufactured and sold by American Chemical Paint Company to the pickling and automobile industries.

48. No licenses have been granted under the Gravell patent, save only the license back to American Chemical Paint Company from defendant when the legal title to the patent was assigned to defendant.

49. Defendant has paid no royalties to American Chemical Paint Company, as provided in the agreement of February, 1938, between American Chemical Paint Company and defendant.

50. As recited in the Gravell patent, the terms "pickle control substances or acid regulators," include organic bases and taken literally comprise thousands of compounds.

51. The Gravell patent recites five specific examples, of which two fail to recite the concentration of the acid, and all of which fail to identify the term "organic bases" wherever the same is recited.

52. Neither the examples of the specification nor the claims of the Gravell patent taken literally identify the term "organic bases."

53. The hydrochloric acid employed by plaintiff in acidizing oil wells is transported to the wells to be acidized in steel transportation tanks and is conducted down the well through a steel pipe.

54. Plaintiff's subsidiary, Dowell Incorporated, adds to the hydrochloric acid before transportation to the well an inhibitor (sodium arsenite) and an acid regulator (alcohol).

PATENT No. 1,877,504

55. The validity of Letters Patent 1,877,504 has been sustained by the United States Circuit Court of Appeals for the 10th Circuit, in Dow Chemical Co. vs. Williams Brothers Well Treating Corporation, 81 Fed. (2) 495, reversing the decision of the United States District Court for the Northern Division of Oklahoma. But the record before this court here contains a large amount of new evidence not before the courts in that case, and this new evidence is of such a character that it may fairly be concluded that the Circuit Court of Appeals for the 10th Circuit would have reached a different conclusion had it been advised of its existence.

56. A substantial part of the crude oil deposits in the United States is in calcareous rock, limestone (calcium carbonate ($CaCO_3$)) or dolomite (a mixture of calcium carbonate with magnesium carbonate, $MgCO_3$). Limestone and dolomite are readily soluble in dilute hydrochloride acid (HCl) with the production of the corresponding chloride ($CaCl_2$ and $MgCl_2$) and the evolution of carbon dioxide gas (CO_2).

57. Physically, the oil bearing rocks vary widely. Some are quite finely porous, the oil filling the pores and clinging to their walls, while others have considerably larger oil filled openings. The underground oil is usually under such pressure that it will flow, more or less rapidly, to a place of reduced pressure, such as exists at the bottom of a well. The pressure is sometimes sufficient to force the oil up the well to the surface, sometimes only enough to cause it to flow or seep into the well from which it must be pumped, and sometimes it is so low that suction must be maintained on the well to assist the oil flow to it.

58. Oil wells are drilled to the oil bearing stratum or "pay." Each is surrounded by a steel casing, often 6 inches in diameter, rising to the ground level from a point above the "pay," leaving an open hole at the bottom into

which the oil flows. Within the casing is the tubing (usually of 2 or 2½ inch soft steel pipe) which extends below the casing into the open hole and carries at its lower end the working barrel and stationary valve of the pump. Within the tubing is the pump rod carrying the valved piston of the pump. The reciprocation of the rod pumps to the surface any oil which has flowed into the hole.

59. Since a single well must drain the oil from a considerable area around it, it is evident that the flow of oil, which may be very slow at a distance from the well, must become constantly faster as it nears the well, since the relatively few openings near the well must carry the oil, which, further away, are carried by a much larger number of openings. The "bottle neck" limiting production is the ability of the ground pressure to force the oil into the congested zone close to the hole. Furthermore, the convergence of oil from all directions in this zone tends to plug it with anything the oil may carry, such as physical dirt or paraffin wax.

60. Not only is the daily production of a well limited by the carrying capacity of the immediately adjacent "pay," but also the economic life of a well ends when the flow to it becomes so small as no longer to justify its operation. This reduction of flow may arise either because the pay immediately around the hole becomes plugged up, or because the decreasing ground pressure will no longer force the oil through this congested area, or both.

61. It is of great importance to increase the ultimate total production of the well by making it possible for the ground pressure to force a large proportion of the total oil into the hole.

62. Long prior to the date of application for the Grebe-Sanford patent in suit it was a well known fact of chemistry that sulphuric acid and hydrochloric acid would attack and decompose limestone. The action of sulphuric acid solution on limestone consumes the acid and produces carbon dioxide gas and calcium sulphate, which is insoluble and is precipitated in the solution, such precipitation tend-

ing to cover the face of the limestone and prevent further action of the acid on it. A hydrochloric acid solution acts on limestone and is consumed to produce carbon dioxide gas and calcium chloride, which is very soluble in the solution, and hence, does not tend to stop the action of the acid by formation of a precipitate.

63. It was also well known long prior to the date of application for the patent in suit that solutions of sulphuric acid and hydrochloric acid likewise act upon iron, steel and other metals, corroding and dissolving them.

64. The Frasch patent No. 556,669, issued in 1896, describes acidizing an oil well with uninhibited hydrochloric acid.

65. According to the invention in suit, an inhibitor is added to the acid. Inhibitors, per se, were very old and well known many years before Grebe and Sanford, and were known to chemists before Frasch's time. Inhibited acid attacks limestone and dolomite as freely as before but its attack on iron is greatly reduced (and in some cases almost wholly prevented). In treating a well by the Grebe and Sanford process the pump rod and its moving valve are withdrawn and the acid is forced down the regular tubing and pump barrel (cylinder) and out into the pay.

66. Prior to the date of the application for the patent in suit, the Gypsy Oil Company had a problem in the Glenpool field, in Oklahoma (a sand formation), caused by formation of "gyp" scale on the casing, tubing, working barrel and pump rods of an oil well, which formation interferred with pumping of the well, and necessitated frequent shut-downs and loss of time for removing rods, valves, etc., and cleaning off the scale. A suitable scale solvent was sought which could be used in the wells to remove scale and thereby to avoid the frequent "pulling" jobs. The problem was submitted to the Mellon Institute at Pittsburgh, the result of tests made at the Institute being contained in a report by Dr. Wescott. The report, while not made public, recommended the use of hydrochloric acid as the scale solvent, and the addition of Rodine, an inhibitor, to the acid

to prevent its attack upon the metal parts of the well. The report also suggested that the use of the acid in the well might also remove gyp from the face of the sand and thereby increase production.

67. In the years 1928 and 1929 the Gypsy Oil Company introduced solutions of hydrochloric acid containing Rodine inhibitor into three of its oil wells located in the Glenpool in Oklahoma. All of said wells were producing oil from the Glenn sand, which is the same as the Bartlesville sand, a member of the Pennsylvania series, and is primarily silica with about 5 per cent calcium carbonate. The three wells above referred to were as follows:

William Berryhill Well No. 8 treated November 12, 1928.

Thomas Gilcrease Well No. 22 treated September 4, 1929.

William Berryhill Well No. 11 treated September 11, 1929.

During such period and subsequent thereto other wells in sand formations were treated by the Gypsy Oil Company with uninhibited hydrochloric acid for scale removal.

68. The claims in issue of Letters Patent 1,877,504 are directed to a purported method for increasing the output of an oil well, which comprises introducing into the well to act upon the formation a hydrochloric acid solution containing or to which has been added a small amount of a corrosion inhibitor or agent capable of inhibiting the action of the acid upon metals, and subsequently withdrawing the spent acid from the well.

69. Dowell Incorporated, on February 10, 1933, treated the Gypsy Oil Company's Well Lovett No. 1 by injecting hydrochloric acid into the formation thereof and this was the first well so treated which was owned by Gypsy Oil Company producing from a limestone formation.

70. Prior to 1932, large amounts of oil were being produced from limestone formations in many states of the United States.

71. The method of acidizing disclosed in the prior

patent to Frasch, 556,669 granted March 17, 1896, was successfully used on a commercial basis in the acidizing of a number of wells near Lima, Ohio, in 1895.

72. The acidizing of oil wells with hydrochloric acid to increase the production of the wells was suggested to the applicants for Letters Patent 1,877,504 by representatives of the Pure Oil Company and was not original with or conceived by such applicants.

73. Prior to Letters Patent 1,877,504, it was well known that numerous agents, including the preferred agent (arsenic compounds) mentioned in Letters Patent 1,877,504, could be added as inhibitors to hydrochloric acid to reduce the corrosive action of the acid upon metals such as steel.

74. Such an inhibitor was added to hydrochloric acid by the Gypsy Oil Company in 1928 for the purpose of reducing the corrosive action of the acid upon the steel pipe and equipment in three wells in sandstone formations when introducing the acid into the wells, the object of this treatment being to remove calcareous scale and deposits therefrom. Such use of hydrochloric acid containing a corrosion inhibitor was reduced to successful commercial practice by the Gypsy Oil Company in 1928 and was not a mere abandoned experiment.

75. The addition of corrosion inhibitors to corrosive acids, including hydrochloric acid, to provide for safely storing and transporting such acids in steel drums or containers is disclosed in the prior patent to Gravell, 1,678,775, granted July 31, 1928, and large quantities of phosphoric acid and pickle control substances containing corrosion inhibitors were shipped commercially by American Chemical Paint Company under such Gravell patent, 1,678,775, long prior to Letters Patent 1,877,504.

76. In adding a corrosion inhibitor to hydrochloric acid for use in acidizing wells, plaintiff was merely making use of the well known qualities of such corrosion inhibitors and obtained no new or unexpected result.

77. The addition of a corrosion inhibitor to the hydrochloric acid employed in an oil well acidizing process creates

no new process of acidizing a limestone formation, and the use of such an inhibitor in an oil well acidizing process is not essential and does not affect the action of the acid upon the formation.

78. The rate of corrosion of raw commercial hydrochloric acid upon steel does not result in any material damage to the well pipe or equipment in the well during a great majority of the usual commercial acidizing operations.

79. Many wells have been acidized successfully with commercial hydrochloric acid using no corrosion inhibitor before and since Letters Patent 1,877,504 issued.

80. It is not established that anyone interested in acidizing a well was ever deterred from so doing by the fear of injury to his well pipe or well equipment or by his inability to resort to the use of well known corrosion inhibitors.

81. The addition of a corrosion inhibitor to hydrochloric acid employed in acidizing an oil well required no more than the ordinary skill of the calling and involved no patentable invention upon the part of the applicants for Letters Patent 1,877,504.

82. Plaintiff, in 1932, was the first to treat the producing formation of a limestone well with inhibited hydrochloric acid charged into the well through the pump tube.

83. Defendant inhibits the hydrochloric acid used in its business of treating wells by the presence in the acid of dissolved lead and copper.

84. Defendant has within six years prior to the filing of the complaint herein, treated oil wells by charging into the well tube, by means of a pump, an inhibited hydrochloric acid solution of about fifteen per cent concentration, expelling such acid solution into the bore of the well to act upon the rock formation surrounding the well cavity, and withdrawing the spent acid.

85. The hydrochloric acid solution employed by defendant in treating oil wells for the Weber Oil Company, in the Eastern District, Northern Division of Michigan, was inhibited due to the presence therein of an agent capable of inhibiting the action of hydrochloric acid on metals.

86. The hydrochloric acid employed by defendant in acidizing oil wells is transported in steel transportation tanks from defendant's storage tanks to the wells to be acidized.

87. The storage-tank acid employed by defendant is commercial hydrochloric acid to which defendant adds no corrosion inhibitor or agent capable of inhibiting the action of the acid upon metals, unless the formation of metallic chlorides (lead and copper), in the transportation tanks, as hereinafter described, be deemed such addition.

88. Defendant bonds a lead plate within the tanks to the steel, thereby producing a battery action causing a flow of electric current from the lead plate through the acid to the steel walls of the transportation tank, and it has been established that this flow of current protects the steel of the transportation tanks.

89. Analyses by plaintiff of raw commercial hydrochloric acid from different manufacturers show traces of copper and lead chlorides and commercial hydrochloric acid containing such chlorides is less corrosive than chemically pure hydrochloric acid.

90. The battery action in defendant's transportation tanks results in the formation of additional minute amounts of copper, lead, and iron chlorides incidental to the operation of defendant's method of protecting its transportation tanks.

91. The presence of such minute quantities of copper, lead, and iron chlorides in the defendant's well acid reduces the corrosive action of the acid, but such acid is more corrosive than the acid resulting from following the example given at lines 74 to 78, page 2 of Letters Patent 1,877,504.

CONCLUSIONS OF LAW

1. Claims 1, 5, 7, 8, and 9, of Letters Patent 1,877,504 are invalid.

2. Defendant would have infringed claims 1, 5, 7, 8, and 9, of Letters Patent 1,877,504 if valid.

3. Claims 1, 2, 3, 6, 7, and 8, of Letters Patent 2,024,718 are invalid.

4. Defendant would have infringed claims 1, 2, 3, 6, 7, and 8, of Letters Patent 2,024,718, if valid.

5. Claims 1, 3, and 6, of Letters Patent 1,678,775, are invalid.

6. Plaintiff would have infringed claims 1, 3, and 6, of Letters Patent 1,678,775, if valid.

DECREE

This cause having been fully tried in open court and the court having made and entered its findings of fact and conclusions of law herein, it is hereby adjudged and decreed as follows:

1. That the complaint be and the same is hereby dismissed as to Letters Patent 1,877,504.

2. That the complaint be and the same is hereby dismissed as to Letters Patent 2,024,718.

3. That, as stipulated, the Grebe patent 1,916,122

issued to plaintiff, The Dow Chemical Company, on June 27th, 1933, for method of treating wells with acid, is good and valid in law and has been the property of plaintiff at all times since it issued.

4. That, as stipulated, the Grebe and Stoesser patent 1,998,756 issued to plaintiff, The Dow Chemical Company, on April 23, 1935, for treating of deep wells, is good and valid in law and has been the property of plaintiff at all times since it issued.

5. That defendant, Halliburton Oil Well Cementing Company, has infringed said Grebe patent 1,916,122.

6. That defendant, Halliburton Oil Well Cementing Company, has infringed said Grebe and Stoesser patent 1,998,756.

7. That in accordance with the stipulation between the parties herein, plaintiff is not entitled in this decree to an order for an accounting of the damages it has sustained and of the profits defendant has received on account of the defendant's infringement of said patents 1,916,122 and 1,998,756.

8. That, as stipulated, an injunction be entered herein enjoining defendant Halliburton Oil Well Cementing Company and its officers and employees from further infringement of said Letters Patent 1,916,122 and 1,998,756, or either of them.

9. That the counterclaim be and the same is hereby dismissed as to Letters Patent 1,678,775.

10. That each party pay its own costs incurred in this action.

Sgd. Arthur J. Tuttle,
United States District Judge.

Dated: September 10, 1941.

NOTICE OF APPEAL

(Filed December 9, 1941)

Notice is hereby given that The Dow Chemical Company, plaintiff herein, hereby appeals to the Circuit Court of Appeals for the Sixth Circuit from the provisions of paragraphs numbered "1" and "2" of the decree entered herein on the 10th day of September, 1941, which dismiss the complaint as to Grebe and Sanford Patent 1,877,504 and as to Chamberlain Patent 2,024,718.

Calvin A. Campbell,
Attorney for Plaintiff, The Dow Chemical Company.

ORDER

The Dow Chemical Company, plaintiff, having on December 9, 1941, filed its notice of appeal herein, for good cause shown it is hereby ordered that appellant's time for filing the record on appeal in the Circuit Court of Appeals for the Sixth Circuit and for docketing the appeal in that court be and the same is hereby extended to the 7th day of March, 1942.

Arthur J. Tuttle,
United States District Judge.

Bay City, Michigan, January 15, 1942.

ORDER

Upon consideration of a petition by the above-named appellant for an extension of time, sixty days beyond March 7, 1942, within which to file the record and docket the appeal in the above cause,

It Is Ordered That the motion be and it is hereby granted.

Approved for entry:

Charles C. Simons,
United States Circuit Judge.

Filed: March 4, 1942.

ORDER

It is ordered that the time for filing record and docketing appeal be extended for a period of ninety days beyond May 6, 1942, pursuant to agreed motion of counsel.

Approved for entry:

Xen Hicks,
Circuit Judge.

Filed: May 6, 1942.

STIPULATION

In view of the situation set forth in a letter written by Chittenden Press to J. W. Menzies, Clerk, United States Circuit Court of Appeals, dated July 13, 1942, copy of which is attached hereto, it is hereby stipulated that the time for filing the record and docketing the appeal herein be extended for a period of three (3) months beyond August 4, 1942.

(S) Wilber Owen,
Of Counsel for Plaintiff-Appellant.
(S) Leonard S. Lyon,
Of Counsel for Defendant-Appellee.

Approved:
Xen Hicks,
Circuit Judge.
Filed: July 18, 1942.

STATEMENT OF POINTS ON WHICH PLAINTIFF-APPELLANT INTENDS TO RELY ON APPEAL

On the appeal, plaintiff-appellant will rely on the following points:

1. The District Court erred in dismissing the complaint as to Grebe and Sanford Patent No. 1,877,504.

2. The District Court erred in failing to decree that Grebe and Sanford Patent No. 1,877,504 is good and valid in law, and particularly Claims 1, 5, 7, 8 and 9 thereof.

3. The District Court erred in not following the decision of the United States Circuit Court of Appeals for the Tenth Circuit in The Dow Chemical Company vs. Williams Brothers Well Treating Corporation, reported at 81 F. (2d) 495, on the question of validity of Grebe and Sanford Patent No. 1,877,504, and in finding as a fact that the record herein contains a large amount of new evidence not before the court in that case and that this new evidence is of such a character that it may fairly be concluded that the Circuit Court of Appeals for the Tenth Circuit would have reached a different conclusion had it been advised of its existence.

4. The District Court erred in failing to find that the evidence before it that was not before the court in The Dow Chemical Company vs. Williams Brothers Well Treating Corporation is insufficient to warrant a different conclusion on the question of validity of the Grebe and Sanford Patent No. 1,877,504 than that reached by the Tenth Circuit Court of Appeals.

5. The District Court, having found infringement, erred in failing to decree the issuance of an injunction against defendant, Halliburton Oil Well Cementing Company, permanently enjoining it from further infringement of said Grebe and Sanford Patent No. 1,877,504.

6. The District Court, having found infringement, erred in failing to decree an accounting by defendant of the profits and advantages that have accrued or that may hereafter accrue to it as a result of its infringements of said

Grebe and Sanford Patent No. 1,877,504, and of the damages plaintiff has sustained or may hereafter sustain by reason of defendant's said infringements.

7. The District Court erred in finding that in adding a corrosion inhibitor to hydrochloric acid for use in acidizing wells, plaintiff was merely making use of the well known qualities of such corrosion inhibitors and obtained no new or unexpected result, and in not finding that the method disclosed and claimed in Grebe-Sanford Patent No. 1,877,504, produced a new and unexpected result which had never before been known or obtained.

8. The District Court erred in finding that the addition of a corrosion inhibitor to the hydrochloric acid employed in an oil well acidizing process creates no new process of acidizing a limestone formation, and in not finding that the step of adding a corrosion inhibitor in an oil well acidizing process for limestone formations together with the elimination of other steps of the acidizing process of the prior art created a new and patentable process which resulted in a new industry in which such inhibiting step was the principal contributing factor.

9. The District Court erred in basing any conclusion of law on the finding that the rate of corrosion of raw commercial hydrochloric acid upon steel does not result in any material damage to the well pipe or equipment in the well during a great majority of the usual commercial acidizing operations, and in not finding that the use by defendant of inhibited hydrochloric acid precludes it from attacking the utility of such process, and that the degree of utility of the Grebe-Sanford process has no effect on the validity of the patent.

10. The District Court erred in finding that many wells have been acidized successfully with commercial hydrochloric acid using no corrosion inhibitor both before and since Letters Patent No. 1,877,504 issued, and in failing to find that the proofs do not establish any successful commercial use of uninhibited hydrochloric acid for acidizing wells in limestone formation to increase their production.

11. The District Court erred in finding that the method disclosed in the Frasch Patent No. 556,669 was successfully used on a commercial basis in the acidizing of a number of wells near Lima, Ohio, in 1895, and in failing to find that said patent disclosed a commercially impractical and unsuccessful method for increasing the flow of oil wells and that the attempts of the owners of said patent to practice said method were abandoned after a short trial period.

12. The District Court erred in failing to find that the process of the Frasch patent, even if conducted with inhibited hydrochloric acid, would not be the equivalent of the Grebe and Sanford process.

13. The District Court erred in basing any conclusion of law on the finding that it is not established that anyone interested in acidizing a well was ever deterred from so doing by the fear of injury to his well pipe or well equipment or by his inability to resort to the use of well known corrosion inhibitors, and in not finding as a fact that since about the year 1897 no wells in limestone formations were successfully treated with hydrochloric acid prior to the Grebe-Sanford invention, and that the fact that no wells were ever so treated with inhibited acid is evidence that the process of Grebe and Sanford constituted a patentable invention.

14. The District Court erred in finding that the use of hydrochloric acid to which had been added an inhibitor for the purpose of reducing the corrosive action of the acid upon the steel pipe and equipment in three wells in sandstone formation, with the object of removing calcareous scale and deposits therefrom, was reduced to successful commercial practice by the Gypsy Oil Company in 1928 or at any other time prior to the invention of the process of the patent in suit by Grebe and Sanford, and in failing to find that such use by the Gypsy Oil Company was a mere abandoned experiment.

15. The District Court erred in finding that the addition of a corrosion inhibitor to hydrochloric acid employed in acidizing an oil well, for the purpose of increasing pro-

duction, required no more than the ordinary skill of the calling and involved no patentable invention upon the part of the applicants for Letters Patent No. 1,877,504, and in not finding that the process described and claimed in said patent constituted a patentable invention as tested both by the history of the art and commercial success.

16. That the District Court erred in failing to decree a recovery from defendant of that portion of plaintiff's costs incurred in connection with its case on the Grebe-Sanford Patent No. 1,877,504 and its defense against defendant's counterclaim.

Wilber Owen,
Don L. Conner,
Attorneys for Plaintiff-Appellant.

Vol. IV

TRANSCRIPT OF RECORD

(Pages 1501 to 2078)

Supreme Court of the United States

OCTOBER TERM, 1944

No. 50

THE DOW CHEMICAL COMPANY, PETITIONER,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY

No. 61

HALLIBURTON OIL WELL CEMENTING COMPANY, PETITIONER,

vs.

THE DOW CHEMICAL COMPANY

ON WRITS OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SIXTH CIRCUIT

PETITIONS FOR CERTIORARI FILED { APRIL 6, 1944.
APRIL 17, 1944.

CERTIORARI GRANTED MAY 15, 1944.

Supreme Court of the United States

OCTOBER TERM, 1943

No. 355

THE DOW CHEMICAL COMPANY, a Corporation,
Petitioner,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY,
a Corporation,
Respondent.

Transcript of Record

On Petition for Writ of Certiorari to the United States Circuit Court of Appeals for the Sixth Circuit

Volume IV—Pages 1501 to 2077

PROCEEDINGS IN THE UNITED STATES CIRCUIT COURT OF APPEALS — SIXTH CIRCUIT

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IN THE

UNITED STATES CIRCUIT COURT OF APPEALS

FOR THE SIXTH CIRCUIT

No.....

THE DOW CHEMICAL COMPANY, A CORPORATION,
Plaintiff-Appellant,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY,
A CORPORATION,
Defendant-Appellee.

Appeal from the United States District Court for the Eastern District of Michigan, Northern Division

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Exhibit Number		Pages Identified	Pages Printed
1	Grebe-Sanford patent in suit 1,877,504	15	1501
2	Grebe patent 1,916,122	15	1504
3	Grebe-Stoesser patent 1,998,756	15	1509
4	Chamberlain patent 2,024,718	15	1512
7	Bureau of Mines Bulletin 148	29	Vol. I, 29
9	Chart of patent applications involving use of acid in wells, filed from 1866 to 1939	63	1515
9½	Revision of Exhibit 9	80	1516
10	Chart entitled "Streams of Knowledge"	65	1517
10½	Prior Art Patents and Publications		1518–88
	Sherwood 57,982	65	1518
	Roberts 59,936	46	1521
	Dickey 106,793	47	1525
	Roberts 119,884	49	1528
	Looney 139,010	66	1530
	Aiken 288,150	86	1531
	Ball 670,577	70	1533
	Mitchell 825,745	50	1537
	Dunn 1,067,868	50	1541
	Muehl 1,410,827	71	1546
	Lake et al. 1,498,045	73	1549
	Tilton 1,608,869	74	1552
	Atkinson 1,651,311	53	1558
	Ranney et al. 1,806,499	75	1565
	Bowman 1,809,546	77	1570
	Young 1,858,847	55	1575
	British Patent 158,768	94	1578
	Millon article (1845)	83	1581
	Conroy article (1901)	87	1584
	Watts article (1912)	89	1587
	Corbett article (1918)	93	1588
12	Summary of Dow Shipments of acid with inhibitors February 11 to November 10, 1932	113	1591–96
13	Letters, dated June 13, 1932, to January 19, 1933, from oil industry inquiring about new Dow process of acid treatments for oil wells	148	1597–1625
14	Item in Midland paper regarding new Dow well treating process, dated June 9, 1932	148	1626

All exhibits are printed in Volume IV unless otherwise indicated.

PLAINTIFF'S EXHIBITS

Exhibit Number		Pages Identified	Printed
19	First invoice of defendant for acidizing well, dated March 11, 1935	248	1627
20	Second invoice of defendant for acidizing well, dated May 25, 1935	248	1628
21	Third invoice of defendant for acidizing well, dated May 25, 1935	248	1628
23	Purchase order from Erle P. Halliburton, Inc., dated 5/21/34, for acid treatment of well by Dowell, Inc.	250	1629
26	Ditto, dated October 24, 1934	250	1630
27	Bulk material sales receipt for 1,000 gal. Dowell X acid delivered by Dowell Inc., to Erle P. Halliburton, Inc., dated November 9, 1934	250	1631
31	Agreement dated March 15, 1934, for acidizing two wells by Dowell, Inc., for Steen Drilling, Inc.	251	1632
34	Agreement dated April 20, 1934, for acidizing ten wells by Dowell, Inc., for Steen Drilling, Inc., or Erle P. Halliburton, Inc.	251	1635
38	Order from Steen Drilling, Inc., dated 3/15/34, for acid treatment by Dowell, Inc.	254	1639
40	Ditto, dated 3/17/34	254	1639
43	Ditto, dated 4/20/34	254	1640
46	Purchase order from Erle P. Halliburton, Inc., dated 5/9/34, for 2,000 gal. acid job by Dowell, Inc.	254	1640
52	Receipt, dated 7/10/34, for well treatment performed by Dowell, Inc., for Erle P. Halliburton, Inc.	254	1641
54	Ditto, dated 7/24/34	254	1642
57	Ditto, dated 8/15/34	254	1643
59	Ditto, dated 9/16/34	254	1644
60	Purchase order from Steen Drilling, Inc., dated 9/16/34, for 1,500 gal. acid job by Dowell, Inc.	254	1645
62	Receipt, dated 10/24/34, for well treatment performed by Dowell, Inc., for Erle P. Halliburton, Inc.	254	1646
64	Ditto, dated 11/14/34	254	1647
66	Ditto, dated 12/19/34	254	1648
67	Stipulation re testimony of R. E. Heithecker.	213	Vol. I, 213
68	Stipulation re testimony of H. C. Miller	235	Vol. I, 235

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PLAINTIFF'S EXHIBITS

Exhibit Number		Pages Identified	Printed
71	Sketches of defendant's truck tank...	262	1649
93	Article in Oil City Derrick of October 10, 1895, entitled "A Great Discovery," reporting acid treatment of well by Frasch and Van Dyke.....	1194A	1651–54
94	Table of Dowell, Inc., statistics showing growth from November 10, 1932, to 1940, inclusive. (See also Plaintiff's Exhibit 232.).....	161	1655
99	Well completion data Greendale (Michigan) oil field.....	168	Vol. I, 168
142	Carnegie Library Card cataloging available issues of Oil City Derrick...	1194A	1656
143	Item in Oil City Derrick for October 28, 1895, reporting acid treatment of wells by Frasch and Van Dyke.....	1194A	1656
144	Ditto, for November 9, 1895.....	1194A	1657
145	Ditto, for January 15, 1896.....	1194A	1658
146	Ditto, for February 20, 1896.....	1194A	1659
147	Ditto, for February 22, 1896.....	1194A	1661
148	Ditto, for March 26, 1896.....	1194A	1661
149	Ditto, for August 10, 1897.....	1194A	1663
150	Stipulation re Williams Bros. record..	13	Vol. I, 13
153	Gypsy Oil Company correspondence and reports re removal of "Gyp" scale and prevention of formation of "Gyp" in oil wells of the Glenpool, Okla., field	1087	1664–1704
154	Bartell Table showing results of corrosion tests with defendant's truck (treating) acids on strap iron test pieces	329	1705
155	Ditto, showing results on test pieces of oil well pipe from National Supply Co.	333	1706
156	Ditto, showing results on test pieces of oil well pipe from Oil Well Supply Co.	333	1707
157	Ditto, showing results on test pieces of oil well pipe from Atha Supply Co..	334	1708
158	Bartell Table showing results of corrosion tests with defendant's storage acids on strap iron test pieces.....	345	1709
159	Ditto, showing results on test pieces of oil well pipe from National Supply Co.	345	1710

All exhibits are printed in Volume IV unless otherwise indicated.

PLAINTIFF'S EXHIBITS

Exhibit Number		Pages Identified	Printed
160	Bartell Table showing analyses of defendant's truck (treating) acid samples	376	1711
161	Bartell Table showing analyses of acid samples taken from defendant's storage tanks	378	1712
162	Bartell Table showing analyses of acid samples taken from defendant's storage tanks and diluted to strength of defendant's truck (treating) acid samples	379	1712
163	Bartell Table showing content of copper, lead and iron in acid used by defendant in treating Zahn well, and same as to acid from defendant's storage tanks	380	1713
164	Bartell Table showing content of copper, lead and iron in acid used by defendant in treating Stella Wilcox well, and same as to acid from defendant's storage tanks	383	1714
165	Bartell Table showing content of copper, lead and iron in acid used by defendant in treating Crawford well, and same as to acid from defendant's storage tanks	384	1715
166	Bartell Table showing results of corrosion tests using c. p. (chemically pure) hydrochloric acid solution containing different amounts of copper, lead and iron	394	1716
167	Bartell Table showing effect of agitation and increased quantity of acid on corrosiveness of acid solutions containing different amounts of copper, lead and iron	407	1719
169	Bartell Table showing amounts of copper, lead and iron in defendant's truck (treating) tank acids and storage tank acids	424	1720
170	Bartell's chart showing effect of adding copper, lead and iron to 15.1% c. p. hydrochloric acid	428	1721

All exhibits are printed in Volume IV unless otherwise indicated.

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Exhibit Number		Pages Identified	Printed
171	Bartell Table showing percentage reduction in corrosiveness of hydrochloric acid resulting from addition of different inhibitors named in Grebe-Sanford patent	451	1723
172	Data showing dates when samples of defendant's treating and storage acids were taken by plaintiff and dates of receipt of acid by defendant	494	1724
173A	Prutton Table showing results of small scale tests of corrosiveness of hydrochloric acid containing different amounts of iron, lead and copper	516	1726
173B	Table comparing results of some of tests shown in Exhibit 173A	516	1727
173C	Ditto	516	1727
173D	Ditto, and description of tests, materials and equipment used and explanation of tables	516	1728–33
176	Prutton Table showing amount of iron dissolved from Series 1 oil well tubing in large scale Run 1A using 15% commercial HCl	508	1734
177	Ditto re Run 1AA	515	1735
178	Ditto re Run 2A using Series 2 tubing	515	1736
179	Ditto re Run 2C using Series 2 tubing	515	1737
180	Ditto re Run 1B using Series 1 tubing and 15% commercial HCl containing small amounts of copper, lead and iron chlorides	517	1738
181	Ditto re Run 2B. Similar to Run 1B, but with Series 2 tubing	517	1739
182	Ditto re Run 2D. Similar to Run 2B, but with different amounts of copper, lead and iron	517	1740
183	Ditto re Run 2E. Similar to Run 2B, but with different amounts of copper, lead and iron	517	1741
184	Prutton's summary and conclusions with respect to runs in Exhibits 176-183.	534	1742–45
185	Prutton Tables showing results of Runs 1M, 1N, 2M and 2N, using commercial acid from special tank embodying features of defendant's truck tanks	537	1746–49
	Sketch showing equipment used in Runs 1M, 1N, 2M and 2N	537	1751

All exhibits are printed in Volume IV unless otherwise indicated.

PLAINTIFF'S EXHIBITS

Exhibit Number		Pages Identified	Printed
186	Defendant's booklet re Howco method	587	Vol. II, 587
187	Prutton graph showing results of runs of Exhibits 176-183	602	1752
188	Prutton graph comparing results of Runs 1M, 1N, 2M and 2N (Exhibit 185) with average of Runs 1A, 1AA, 2A and 2C (Exhibits 176-179)	604	1753
189	Prutton graph showing results of tests of 15% c. p. hydrochloric acid with different added amounts of copper, lead and iron	605	1754
192	History of oil development in limestone fields prior to 1932 and history of acidizing in those fields beginning in 1932, prepared by the witness Fitzgerald	178	1755–70
195	Item from Montana Oil & Mining Journal for January 26, 1935, reporting increase of production in Pondera (Montana) field, due to acidizing	186	1770
196	Bulletin of Montana Oil Conservation Board	189	Vol. I, 187
199	Letter, Dow Co. to Oil Makers, 9-23-32	1171	Vol. III, 1172
200	Letter, Grasselli to Oil Makers, 10-14-32	1174	Vol. III, 1174
201	Letter, Grasselli to Oil Makers, 11-1-32	1175	Vol. III, 1175
202	Letter, Grasselli to Oil Makers, 1-26-33	1176	Vol. III, 1178
203	Letter, Grasselli to Oil Makers, 9-15-32	1179	Vol. III, 1179
204	Letter, Oil Makers to Grasselli, 10-8-32	1179	Vol. III, 1180
205	Oil Makers checks to Penn. Salt Co.	1196	Vol. III, 1196
216	Letter, Lee to Oil Makers, 2-7-33	1243	Vol. III, 1242
218A-218D	Pages from notebook kept by the witness Sprenger	1257	1772–74
219, 220	Photograph of standing valve and working valve	1268	1775
228	Letter, Prutton to Rebbeck, 1-28-41	799	1776
231A-231J	Dow Company's records of shipments of acid to Pure Oil Company during period from February to May, inclusive, 1932	140	1777–86
232	Table supplementing Exhibit 94	845	1787
233	Summary of well treatments made by licensees of Dow other than Dowell	845	1788

All exhibits are printed in Volume IV unless otherwise indicated.

PLAINTIFF'S EXHIBITS

Exhibit Number		Pages Identified	Printed
234	Sketch and data prepared by Dr. Prutton showing rates of attack on oil well tubing of 15% c. p. hydrochloric acid and of 15% synthetic defendant's treating acid	840	1789
242	Dowell advertisement in Petroleum World, September, 1938	846	1790
243	Ditto for January, 1939	847	1791
245	Dowell, Inc., Service Price Schedule 110.	852	1792
246	Record of shipments of hydrochloric acid and arsenic inhibitor by Dow Company for period January to June, 1932, inclusive	121	1793
305	Affidavit of Robert Quinlan on the first treatment of a Pure Oil Company well with inhibited hydrochloric acid	1028	1794
328	Table showing results of acid treatments of gas wells by Dowell, Inc., prepared by the witness Lyons	191	1796
329	Ditto, showing additional treatments and data	193	1797
330	Table showing time acid was in tubing in each of 122 acid treatments made by Dowell in Kansas from March to September, 1936, in 97 consecutive Arbuckle dolomite wells	197	1798
331	Data showing average time acid was in tubing in making the 122 treatments itemized in Exhibit 330	197	1799
337	Chart showing combinations possible under claims of Gravell Patent 1,678,775.	1320	1800
343	Alquist Table showing rate of corrosion of mild steel in various concentrations of hydrochloric acid	1365	1801
	Charts forming part of Exhibit 343	1365	1802-03
344	Alquist Table showing acceleration of the rate of corrosion of hydrochloric acid containing an acid regulator caused by the addition of tin, cobalt or nickel	1370	1804
	Chart forming part of Exhibit 344	1370	1805
347	Table supplementing Plaintiff's Exhibit 252	1404	1806
348	Table showing treatments by Dow licensees other than Dowell	1404	1807

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Exhibit Number		Pages Identified	Printed
349	Table showing summary of royalty charged by Dow Company to licensees.	1404	1808
350	Table showing quantities of inhibited acid and other materials used by Dowell, Inc.	1405	1809
350A	Graph illustrating data in Exhibit 350.	1407	1810
351	Acidizing orders, tickets and other data from defendant's files relating to wells at which plaintiff secured samples of defendant's truck (treating) acids	1406	1811–24
354	Dowell advertising data for years 1932 to 1934	1407	1825
355	Photograph of one-half gallon container used in Alquist's tests, and table and graphs showing results of tests.	1376	1827–29
356	Photographs of 10-gallon drum and of equipment used by Alquist in making tests, and tables and graphs showing results of such tests.	1380	1830–40
357	Table, graphs and drawing of equipment used by Alquist in making tests showing loss of strength of 15% hydrochloric acid when in contact with iron for different periods up to 24 hours.	1398	1841–46
358	Bartell Table showing summary of corrosion tests of various commercial hydrochloric acids of 15.1% strength.	499	1847
360	Table showing Dowell advertising 1932 to 1940, inclusive	1408	1848
362	Poffenberger's report on acid treatment of Dow Company's brine well No. 77	1418	1849–53
363	Poffenberger's report on acid treatment of Dow Company's brine well No. 80	1418	1854
364	Poffenberger's report on tests of inhibiting value of arsenic compounds in hydrochloric acid	1423	1855
366	Carr and Humphrey patent application for method for increasing fluid production from oil wells	1427	1857–64

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PLAINTIFF'S EXHIBITS

Number Exhibit		Identified	Printed Pages
367	Carr and Humphrey patent application on chemical reagent for use in oil wells	1428	1864–68
368	Carr and Humphrey patent application for method for introducing acid reagents into oil wells by gas pressures	1428	1868–72
369	Agreement between The Dow Chemical Company and The Pure Oil Company dated January 31, 1933	1428	1873–77
370	Agreement between The Dow Chemical Company and The Pure Oil Company dated June 30, 1934	1428	1877–82

DEFENDANT'S EXHIBITS

8	Excerpts from article by R. Van A. Mills, dated December, 1923, entitled "The Paraffin Problem in Oil Wells".	35	1883
72	Letter from M. G. Harper to J. W. Van Dyke, dated December 5, 1895	1033	1884
73	Telegram, Harmon to Van Dyke, dated January 24, 1896	1033	1885
74	Memo from C. F. Lufkin to Van Dyke, undated	1033	1886
83	Telegram, J. C. Donnell to Van Dyke, dated November 25, 1895		1887
86	Telegram, Harper to Van Dyke, dated December 6, 1895		1887
88	Letter, The Grasselli Chemical Company to Van Dyke, dated July 26, 1895		1888
90	Letter, Herman (Frasch) to Van Dyke, dated September 22, 1895		1889
101	Letter, Harper to Van Dyke, dated December 16, 1895	1033	1890
102	Letter, Harper to Van Dyke, dated December 16, 1895	1047	1891
103	Letter, Ohio Rubber Company to Solar Refining Co., dated September 21, 1895	1047	1892
104	Letter, Ohio Rubber Company to Solar Refining Co., dated September 25, 1895		1893
105	Memo re Crossley Well No. 3 of Ohio Oil Company	1047	1894

All exhibits are printed in Volume IV unless otherwise indicated.

DEFENDANT'S EXHIBITS

Exhibit Number		Pages Identified	Printed
108	Letter, Harper to Van Dyke, dated February 5, 1896	1047	1895
109	Correspondence between Lufkin, Van Dyke and Donnell re acid treatments (July, 1895, and February, 1896)	1047	1896
110	Letter, Lufkin to Van Dyke, dated July 29, 1895		1900
111	Letter, Harper to Van Dyke, dated December 2, 1895	1047	1902
112	Letter, Grasselli Chemical Company to Van Dyke, dated November 21, 1895		1903
113	Letter, Van Dyke to Grasselli Chemical Co., dated November 20, 1895		1904
114	Memo dated November 21, 1895		1905
115	Letter, Frasch to Van Dyke, undated		1905
132	Letter, Grasselli Chemical Co. to Van Dyke, dated July 19, 1895		1906
138	Letter, Lufkin to Van Dyke, dated August 2, 1895		1907
151	Report on scale formation in wells by Blaine B. Wescott	1081	1908–21
152	Report by F. W. Karl, dated February 1, 1929, re treatment of William Berryhill Well No. 8	1087	1922
153	Same as Plaintiff's Exhibit 153	1087	1664–1704
191	Gardner Affidavit	750	Vol. II, 752
221	Letter, Robinson to Prutton, 9-12-39	769	Vol. II, 769
222	Letter, Rebbeck to Prutton, 1-24-41	771	Vol. II, 772
223	Letter, Prutton to Rebbeck, 2-19-41	774	Vol. II, 775
224	Letter, Rebbeck to Prutton, 7-10-41	791	Vol. II, 791
225	Letter, Rebbeck to Prutton, 7-9-41	792	Vol. II, 791
226	Letter, Rebbeck to Prutton, 7-9-41	792	Vol. II, 793
227	Letter, Rebbeck to Prutton, 7-11-41	792	Vol. II, 793
280	Hathorn's chart re tests on hard steel tank No. 1	854	1924
281	Hathorn's chart re tests on hard steel tank No. 2	854	1925
282	Hathorn's chart re tests on hard steel tank No. 3	854	1926
283	Hathorn's chart re tests on soft steel tank No. 4	854	1927
284	Hathorn's chart re tests on soft steel tank No. 5	854	1928
285	Hathorn's chart re tests on hard steel tank No. 1	854	1929
286	Hathorn's chart re tests on soft steel tank No. 4	854	1930

All exhibits are printed in Volume IV unless otherwise indicated.

DEFENDANT'S EXHIBITS

Exhibit Number		Pages Identified	Printed
287	Index for Hathorn's corrosion experiments	855	1931
288	Photograph of Hathorn's hard steel tank No. 1	855	1932
289	Photograph of Hathorn's soft steel tank No. 4	855	1933
294	Prior art patents	912	1935–88
	Frasch 556,669	68	1935
	Laverty 856,644	913	1939
	Beneker 914,916	915	1941
	Gravell 1,398,507		1943
	Holmes 1,470,225	916	1945
	Gravell 1,678,775	95, 897	1947
	Gravell and Douty 1,678,776		1950
	Fischer et al. 1,736,282	917	1954
	Rhodes 1,746,677	918	1957
	Rhodes 1,746,678	920	1961
	Vignos 1,750,651	920	1964
	Harrison 1,766,902	921	1968
	Corson et al. 1,773,953	921	1971
	Lawrence 1,780,594	922	1974
	Lawrence 1,780,595		1976
	Calcott 1,785,513	923	1978
	Burke 1,789,805	923	1980
	Corson 1,809,621	923	1985
	Carr 1,891,667	76	1988
300	Memorandum given by Grebe to defendant's witness Thomas	1012	1993
301	Letter, C. Plummer to The Dow Chemical Company, dated December 1, 1932	1016	1994–97
302	Memorandum of conversation with Ross T. Sanford, dated December 8, 1932.	1016	1998–99
303	Memorandum of conversation with John J. Grebe, dated December 8, 1932.	1023	2000–02
304	Preliminary draft of patent application of John J. Grebe, dated June 7, 1932.	1025	2002–09
312	File history of Grebe and Sanford patent 1,877,504		2010–46
314	Conception data sheet signed by John J. Grebe July 2, 1932		2047

All exhibits are printed in Volume IV unless otherwise indicated.

PLAINTIFF'S EXHIBIT 10½

ENGINEERING SOCIETIES LIBRARY
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Memoir on the Decomposition of Water by Metals, in the Presence of Acids and Salts.

By E. Millon

(Translated from Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, vol. 21 (1845) (p37-50)

The impairment of metals, either by pure water or by water charged with acid or saline principles, is a phenomenon that occurs frequently in the laboratory: this phenomenon also concerns our domestic uses and, among industrial facts, it certainly has an important place.

The experiments that I am about to describe are all connected with this impairment of metals by water in the presence of acids or salts; they only comprise, in a word, a simple indication of some circumstances under whose action the common metals, iron, zinc, tin, copper, are attached and sometimes preserved. But among all these circumstances, there is one that I shall point out at once, because I think its intervention has been almost unnoticed heretofore: I wish to call attention to the influence of small quantities.

This influence, if I do not mistake the first impression that I have received is considerable.

If one should say, indeed, that a little quantity of metallic solution, added in the proportion of one thousandth, of one hundred-thousandth, and often in a smaller proportion, was sufficient to increase a hundred fold the action of an acid on a metal, or to annihilate this action, or to provoke it when it did not exist, or finally even to change the nature of the products to such a point that hydrogen replaces nitrous compounds, one would seem to be, in such

an assertion, as far from the facts as from chemical predictions.

Nevertheless, that is what happens.

The details of the experiments will show how easy it is to reproduce all these phenomena.

Of zinc and the decomposition that it exerts, by means of small metallic quantities, on acid or saline solutions or on pure water itself.

Zinc and sulfuric acid.—Several chemists have already reported the peculiar resistance that zinc sometimes opposes to the solvent action of dilute sulfuric acid. The usual disposition is to attribute this resistance to the purity of the metal, which will not decompose water readily but by means of some foreign metal combined with the zinc. Here, the phenomenon has been considered in a different manner: the metal has been taken as it is found in commerce, while the acid, saline water or pure water itself has received a small quantity of foreign saline solution before being brought in contact with the zinc.

Thus, rolled zinc has been brought into the presence of dilute sulfuric acid to which has been added some traces either of platinous chloride, or of tartar emetic, arsenious acid, copper sulfate, silver sulfate, etc. The metal, weighed before the reaction, was weighed again after the reaction had lasted for a definite time. In other instances, the gas was collected and measured.

I shall indicate the principal conditions of the experiments made by means of zinc and dilute sulfuric acid.

The zinc was rolled in sheets thin enough to give 100 to 102 cm. of surface per weight of 15 grams.

The sulfuric acid was composed of 1 part of monohydrated sulfuric acid SO_4H_2O to 12 parts of distilled water.

The zinc was weighed exactly, and six nearly equal quantities of water were introduced into six glass flasks, each of which contained 1½ deciliters of the one-to-twelve sulfuric acid; the flasks were distinguished by the numbers 1, 2, 3, 4, 5 and 6.

In flask no. 1, the acid remained pure; no. 2 received 4

drops of platinous chloride solution made with 1 part of chloride and 10 parts of water; nos. 3, 4, 5 and 6 received some drops of saturated solutions of tartar emetic, arsenious acid, copper sulfate and silver sulfate.

The duration of the experiment was 10 minutes for each flask.

Iron and Tin

Iron and tin have been subjected to tests analogous to those of zinc.

One-to-twelve sulfuric acid dissolves iron turnings rather rapidly; some drops of platinous chloride communicate an extreme intensity to this action. Arsenious acid, on the contrary, stops all action on iron by sulfuric acid; this influence is sufficiently pronounced for the metallic iron to keep for a whole month, and without doubt still longer, in one-to-twelve sulfuric acid, which dissolves it rather rapidly. When the iron is well cleaned, some drops of an aqueous solution of arsenious acid are sufficient to preserve it from the acid; at the same time it preserves metallic reflection whose shade becomes only rather darkened.

Tartar emetic slackens the action of sulfuric acid on iron, but does not stop it. Mercurous chloride acts like tartar emetic. Copper sulfate accelerates strongly the evolution of hydrogen; silver sulfate also accelerates it, but less appreciably.

Hydrochloric acid receives, from small quantities of metals, the same influence as dilute sulfuric acid; these reactions can even be observed with rather concentrated hydrochloric acid; it is sufficient to dilute the pure fuming acid with 2 or 3 volumes of water. In some cases the addition of a small quantity of copper sulfate has suspended very appreciably the action of hydrochloric acid. The iron becomes covered with metallic copper and remains for several hours without furnishing hydrogen; but it has not always been thus, without it being possible to ascertain whether this difference depended on the hydrochloric acid or the iron.

* * * * *

Plaintiff's Exhibit 10½

THE JOURNAL OF THE SOCIETY OF CHEMICAL INDUSTRY
(April 30, 1901)

THE RATE OF DISSOLUTION OF IRON IN HYDROCHLORIC ACID

By James T. Conroy, B.SC., Ph.D.

The behaviour of acids towards metals is a problem of great interest, both to the chemist and the manufacturer, and such behaviour has been the subject of considerable investigation.

Sometimes, perhaps most frequently, it is the manufacturer's object to obtain a metal not acted upon by some particular acid; at other times action is desired, and in this case a knowledge of the course of the reaction, its rate, and the conditions under which it occurs is of the greatest importance.

To take a particular instance, I may refer to the cleaning of iron by acids—the so-called "pickling" process—a preliminary operation in the preparation of this metal for the galvanising bath. In an industry of this nature, where the various units of plant for the several operations are designed to deal with the same quantity of material, and will do so under certain definite conditions, the importance of knowing and being able to control these conditions will be readily recognised. That these conditions are not always known, even in large and prosperous works, I have had opportunity to learn. As a matter of fact, the present investigation arose out of the marked difference in the work done on a manufacturing scale by acids of equal chemical purity. The only apparent differences in the conditions at the starting of the pickling operation were in the concentration of the acids and the temperatures of the two baths, and these differences appeared almost too slight to account for the great variation in activity between the so-called "good" and "bad" acids.

I felt, however, that these differences were points worth

following up, and I consequently investigated the effect of concentration and temperature on the rate of dissolution of iron in hydrochloric acid, the acid generally used for "pickling."

So far as I am aware, nothing has been published on this particular subject, although, as before stated, the amount of work done on the interaction of acids and metals has been very great. The results obtained in the various cases show how impossible it is to prophesy what will occur, even as regards the nature of the reaction, under any specified conditions; each case requires its own separate investigation. Thus sulphuric acid will only react with certain metals when hot and concentrated, the gaseous products of reaction being sulphurous anhydride. With other metals it will react in the cold, and at almost any strength, with evolution of hydrogen; but even with most of these latter metals it will give sulphurous acid when heated. With iron, whilst strongly active at certain concentrations, it becomes almost inactive at some definite intermediate concentration.

* * * * *

Effect of Concentration on the Activity.—My first experiments were done to find out the effect of the concentration of the acid on the rate of dissolution, and they consisted in noting the loss of weight suffered at ordinary temperature by pieces of iron of the same area in acids of various strengths.

The iron used was the black sheet of the galvaniser, that is, the iron as ready for the pickling bath after annealing. Each piece measured 5 cm. × 2½ cm., and was immersed standing on end in a small beaker containing 50 c.c. of hydrochloric acid, this quantity of acid being just sufficient to cover the metal. The loss of weight was determined after intervals of 1, 2, 3, &c. hours, the metal being in each case washed with water and alcohol before drying. The acid concentration in the several beakers varied from 25 to 358 grms. per litre.

The results obtained indicated that over this range of concentration the amount of action was not directly propor-

tional to the acidity of the solution. Thus, with a decrease of 10 per cent in the quantity of real acid present (from 310 grms. to 280 grms. per litre) the rate of solution fell to 50 per cent; that is, at the lower concentration it was only one-half its value at the higher. Although the results obtained could not be represented by a straight line, the values, however, seemed to follow a regular curve.

* * * * *

The foregoing experiments were all done with distilled hydrochloric acid practically free from impurity of any kind. In practice commercially pure acid is employed. Such acid must be free from arsenic, the presence of which is prejudicial during the pickling stage, apart from the trouble it causes later on in the galvanising bath. The effect produced when arsenic is present in small quantity is shown is Table IV. When larger quantities are present the iron becomes completely covered with a film of arsenic, which, at ordinary temperature, almost completely checks further action, even with the more concentrated acids.

TABLE IV

HCl, Grms. per Litre.	As_2O_3, Grms. per Litre.	t° C.	C.c. Hydrogen evolved per 1 hour		Rising to	In Minutes.
			Before addition of As_2O_3.	After addition.		
200	0.08	18	30	21	26	50
200	0.16	18	26	19	26	60
216	0.04	18	12.6	5	..	..
180	0.08	54.5	304	120	248	40
180	0.08	55	370	156	345	60
180	0.08	61.5	522	220	470	40
216	0.04	56	425	305	..	..

* * * * *

Plaintiff's Exhibit 10½

TRANSACTIONS
of the
AMERICAN ELECTROCHEMICAL SOCIETY

Volume XXI

TWENTY-FIRST GENERAL MEETING
Boston, Mass., April 18, 19, 20, 1912

THE EFFECT OF VARIOUS SUBSTANCES ON THE RATE OF CORROSION OF IRON BY SULPHURIC ACID

By Oliver P. Watts

In Vol. 8 of the transactions of this society, C. F. Burgess called attention to the remarkable reduction in the corrosion of iron by sulphuric acid, brought about by the addition of a small amount of arsenious oxide to the acid. Later he explained the protective action as follows: "The explanation which has been offered for this phenomenon is that the iron receives, by contact with the solution, an extremely thin coat of arsenic which resists the action of the acid and protects the underlying metals." He also gave experimental proof that the iron was coated with arsenic.

* * * * *

On the theory that the protection of iron by a deposit of arsenic is due to the high overvoltage of hydrogen on the latter the action would be as follows: Iron dissolves and by so doing deposits arsenic upon the surface of the iron. Since the arsenic is deposited simultaneously with the dissolving of the iron, and only as a result of this dissolving, it is hardly possible that the iron should be perfectly covered by arsenic, but here and there holes will exist, allowing the iron to make contact with the electrolyte. Voltaic cells are thus formed. From the single potentials of iron and of arsenic, + 0.093 and — 0.550, these cells should have an electromotive force of 0.64 volts, and the corrosion of the

iron ought to be very vigorous. It is here that the over-voltage of hydrogen comes in play. The iron is anode and the arsenic cathode, and, just as in any other primary cell with sulphuric acid as electrolyte, hydrogen is deposited on the cathode. But when hydrogen is liberated on arsenic the potential of the latter is raised 0.39 volts higher than —0.277, the potential at which hydrogen is liberated on platinum-black. This would raise the potential of the arsenic to + 0.113 volts, or higher than the potential of the iron anode. This means that in our iron-arsenic cell there can be no visible evolution of hydrogen on the arsenic, for before this can occur the potential of the cathode has become equal to that of the anode, and corrosion of the iron ceases, in other words, this particular primary cell polarizes so badly that after a few seconds of action its electromotive force has fallen to zero.

• • • • •

DEPARTMENT OF THE INTERIOR
Franklin K. Lane, Secretary

BUREAU OF MINES
Van. H. Manning, Director

SUBSTITUTION OF NITRE CAKE FOR SULPHURIC ACID IN PICKLING STEEL

By E. E. Corbett, Chemical Engineer,
U. S. Bureau of Mines

Washington, D. C. October, 1918

PURPOSE AND SCOPE OF THE INVESTIGATION

As far as can be ascertained there have been few thorough-going endeavors to place on a broad working basis the pickling of steel for the removal of oxide scale. Such systematic researches as have been inaugurated and carried out have had as their object the establishment of a few simple methods applicable to a somewhat narrow procedure, of immediate bearing on a few specific problems,

and with apparent disregard of the fact that while various shapes and sizes require modification of apparatus and means of handling, the solution principles involved in the chemical processes are essentially the same. The various processes in use, therefore, are for the most part empirical and, indeed, somewhat inflexible to changes which tend materially to alter the mode of working the solutions.

* * * * *

INHIBITION, OR MODERATION OF METAL ATTACK

3. The activity of the acid, then, is directed to attacking selectively and dissolving the sound metal rather than the more resistant oxide or scale; but in well-regulated pickling practice the selective attack is limited, and, indeed, materially redirected and controlled by the use of bodies of a colloidal or semi-colloidal nature whose influence serves to protect the metal during scale removal. These bodies are for the most part of vegetable origin, and comprise various wood sugars and gums, and cereal starches, and intermediates occurring in commercial grain milling.

Specifically, the organic substances which have been successfully used for this purpose, in quantities sufficiently small as to give simply a distinct film to the surface of the bath under temperature conditions which moderate the charring of the inhibitor by hot acid solution, are listed below:

Molasses	Fermented yeast
Sugars	Spent tan-bark
Cornstarch	Bran
Peanut meal	Middlings
Quebracho fiber	Rye Flour

The inhibitor is usually prepared as a fermented swill or mash which is added to the bath at intervals determined by the rate at which its influence is destroyed by the chemical action of the acid.

Soap-bark and the various foam compounds in use are of an inhibitory nature. The last-named commercial preparations are essentially concentrated sulphite pulp ex-

tracts placed on the market as strong solutions or as powders incorporated with ground nitre cake and rock salt.

Tin and copper salts are representatives of the inorganic type of semi-colloidal inhibitors; but their action is of inferior consequence and their use restricted because of the cost of adding to the bath quantities sufficiently large to exercise a sensible influence, as well as their tendency, undesirable for most purposes, to plate out from solution upon the metallic surface.

The precise chemical mechanism of the inhibitor in solution has not been established; its beneficial action, however, both in limiting surface corrosion of metals, and in reducing the fume nuisance in pickling rooms is beyond question. It is believed, more commonly than logically, that a small quantity of one of these substances, thrown upon the surface of an active solution simply prevents the escape of disagreeable gases by blanketing the bath and absorbing the vapors—this, notwithstanding the difficulty of comprehending how hydrogen may be so blanketed, above a solution whose temperature rises close to the boiling point of water. It is a fact, however, that the surface tension of such a film does prevent to an appreciable degree, globules of acid solution from being forced almost explosively into the atmosphere surrounding the vats.

Nevertheless the main value of the inhibitor, from the pickling viewpoint, lies in the modifying action which it exerts on the tendency of the acid to attack the sound metal rather than the scale; and this moderating influence first shows itself in the comparatively lesser volume of non-condensible gas, chiefly hydrogen, which rises from the surface of the solution. The solution is no longer a system of acid in water, but acid in an emulsion of a starch or sugar with water; hence, in the different pickling medium the acid is carried by an organic vehicle in which its properties are necessarily modified. Similarly, the catalytic accelerating function of the ferrous sulphate in solution is neutralized; its dissociation value is reduced in the new medium, its sensible influence thus rendered comparatively inert.

PLAINTIFF'S EXHIBIT 12

SUMMARY OF ACID SHIPMENTS

Date	Oil Company	Identification Gals.	Per Cent	Inhibitor
2-11-32	Pure Oil Co.	500	15	2 gals. arsenic
3-11-32	" " "	500	15	2 " "
4- 5-32	" " "	500	15	4 " "
4-27-32	" " "	500	15	(4-5-32/4-27-32)
5- 5-32	" " "	500	15	12 gals. arsenic
5-21-32	" " "	500	15	(5/5/32-5/31/32)
5-25-32	" " "	500	15	
5-27-32	" " "	500	15	
5-28-32	" " "	500	15	
5-31-32	" " "	500	15	
6- 1-32	Columbia Oil & Gas Co.	80# 6 cbys.	15	44 gals. arsenic
6- 3-32	Pure Oil Co.	500	15	Pure Oil
6- 4-32	Columbia Oil & Gas Co.	53# 4 cbys.	15	28 gals. arsenic
6- 4-32	Lawrence Lee	500	15	Misc.
6- 7-32	Columbia Oil & Gas Co.	80# 6 cbys.	15	(6/1/32-6/30/32)
6- 9-32	Lawrence Lee	500	15	
6-11-32	Pure Oil Co.	500	15	
6-13-32	" " "	500	15	
6-15-32	" " "	500	15	
6-16-32	Chippewa Oil & Gas Co.	500	15	
6-17-32	Mt. Pleasant Oil & Gas Co.	500	15	
6-17-32	Pure Oil Co.	500	15	
6-16-32	W. L. McClanahan	500	15	
6-18-32	Lawrence Lee	500	15	
6-18-32	Talbot Oil Co.	500	15	
6-20-32	Pure Oil Co.	500	15	
6-20-32	Lawrence Lee	500	15	
6-20-32	The Gordon Oil Co.	500	15	
6-21-32	Pure Oil Co.	1000	15	
6-22-32	Stork Oil Co.	500	15	
6-22-32	Pure Oil Co.	1000	15	
6-23-32	Pure Oil Co.	1000	15	
6-24-32	Pure Oil Co.	1000	15	
6-25-32	Pure Oil Co.	1000	15	
6-25-32	Michigan Gas & Oil Co.	500	15	
6-27-32	Pure Oil Co.	1000	15	
6-28-32	Lupher Drilling Co.	25# 2 cbys.	15	
6-28-32	Ohio Produc. & Ref. Co.	500	15	
6-28-32	Pure Oil Co.	1000	15	
6-29-32	Lawrence Lee	1000	15	
6-30-32	Pure Oil Co.	1000	15	
6-30-32	Lawrence Lee	500	15	

Plaintiff's Exhibit 12

Date	Oil Company	Identification Gals.	Per Cent	Inhibitor
7- 1-32	Pure Oil Co.	1000	15	116 gals. arsenic
7- 5-32	" " "	1000	15	Pure Oil
7- 5-32	" " "	1000	15	44 gals. arsenic
7- 5-32	" " "	1000	15	Misc.
7- 5-32	Leonard Petroleum Co.	500	15	(7-1-32/7-25-32)
7- 5-32	Sias Oil Co.	500	15	
7- 6-32	Pure Oil Co.	1000	15	
7- 6-32	Stork Oil Co.	500	15	
7- 7-32	Pure Oil Co.	1000	15	
7- 7-32	" " "	1000	15	
7- 8-32	" " "	1000	15	
7- 8-32	Lawrence Lee	500	15	
7- 8-32	Chippewa Oil & Gas Co.	500	15	
7- 8-32	Ohio Prod. & Ref. Co.	500	15	
7- 8-32	Lawrence Lee	500	15	
7- 8-32	Pure Oil Co.	1000	15	
7-11-32	McClanahan, Well #10	500	15	
7-11-32	Pure Oil Co.	1000	15	
7-12-32	" " "	1000	15	
7-14-32	Ohio Prod. & Ref. Co.	500	15	
7-14-32	Pure Oil Co.	1000	15	
7-15-32	" " "	1000	15	
7-15-32	Talbot Oil Co.	500	15	
7-13-32	Leonard Petroleum Co.	500	15	
7-15-32	Pure Oil Co.	1000	15	
7-18-32	" " "	1000	15	
7-18-32	" " "	1000	15	
7-18-32	Chippewa Oil & Gas Co.	500	15	
7-19-32	Pure Oil Co.	1000	15	
7-19-32	Sias Oil Development Co.	500	15	
7-20-32	Pure Oil Co.	1000	15	
7-20-32	Sias Oil Co. (Brown A-1)	500	15	
7-21-32	Michigan Gas & Oil Co.	500	15	
7-21-32	Pure Oil Co.	1000	15	
7-22-32	" " "	1000	15	
7-22-32	Charlotte G. Marsh	500	15	
7-25-32	Gordon Oil Co.	500	15	
7-25-32	Pure Oil Co.	1000	15	
7-25-32	" " "	1000	15	
7-26-32	" " "	1000	15	
7-28-32	" " "	1000	15	
7-28-32	" " "	1000	15	
7-28-32	Columbia O. & G. Co. (Homick 1)	500	15	
7-29-32	C. W. Marsh	500	15	
7-29-32	Sias Oil Development Co.	500	15	
7-13-32	Pure Oil Co.	1000	15	
7-30-32	Gordon Oil Co.	500	15	
7-30-32	Pure Oil Co.	1000	15	
7-30-32	" " "	1000	15	
7-30-32	Columbia Oil & Gas Co.	500	15	
7-25-32	Pure Oil Co.	1000	15	

Plaintiff's Exhibit 12

Date	Oil Company	Identification Gals.	Per Cent	Inhibitor
8- 1-32	Pure Oil Co.	1000	15	96 gals. arsenic
8- 2-32	" " "	1000	15	Pure Oil
8- 2-32	Reed Oil Co.	500	15	110 gals. arsenic
8- 3-32	Producers Service Co.	500	15	Misc.
8- 4-32	Talbot Oil Co.	500	15	(8/1/32-8/31/32)
8- 4-32	Pure Oil Co.	1000	15	
8- 5-32	" " "	1000	15	
8- 5-32	Gordon Oil Co.	500	15	
8- 8-32	Reed Oil Co.	500	15	
8- 8-32	W. T. McIntosh	500	15	
8- 8-32	Pure Oil Co.	1000	15	
8- 8-32	" " "	1000	15	
8- 9-32	" " "	1000	15	
8- 9-32	Chippewa Oil Co. (2 loads)	1000	15	
8- 9-32	Leonard Petroleum Co.	500	15	
8- 9-32	W. T. McIntosh	500	15	
8-11-32	Mt. Pleas. O. & G. Co. (2 lds.)	1000	15	
8-11-32	Pure Oil Co.	1000	15	
8-12-32	" " "	1000	15	
8-12-32	Talbot Oil Co. (Adams #3)	500	15	
8-13-32	Sias Oil Co.	500	15	
8-13-32	Mt. Pleasant Oil & Gas Co.	1000	15	
8-15-32	Pure Oil Co.	1000	15	
8-15-32	" " "	1000	15	
8-16-32	Perkins Bros.	500	15	
8-16-32	Shoup Oil Co.	500	15	
8-16-32	Pure Oil Co.	1000	15	
8-17-32	" " "	1000	15	
8-17-32	Reed Oil Co.	500	15	
8-18-32	Michigan Gas & Oil Co.	1000	15	
8-18-32	Pure Oil Co.	1000	15	
8-19-32	Swastika Oil & Gas Co.	500	15	
8-19-32	Ohio Prod. & Ref. Co.	1000	15	
8-19-32	Pure Oil Co.	1000	15	
8-19-32	Simrall Refining Corp.	tank car	20° Be	
8-20-32	Gordon Oil Co.	1000	15	
8-20-32	" " " Sk #4	500	15	
8-20-32	Reed Oil Co.	1500	15	
8-20-32	Pure Oil Co.	1000	15	
8-22-32	" " "	1000	15	
8-23-32	The Wittmer Co.	1000	15	
8-24-32	Meridan Oil & Gas Co.	1000	15	
8-24-32	Pure Oil Co.	1000	15	
8-25-32	" " "	1000	15	
8-25-32	Sias Oil Development Co.	1000	15	
8-26-32	Mt. Pleasant Oil & Gas Co.	1000	15	
8-26-32	Swastika Oil Co.	1000	15	
8-26-32	Gordon Oil Co.	500	15	
8-27-32	Reed Oil Co.	1000	15	

Plaintiff's Exhibit 12

Date	Oil Company	Identification Gals.	Per Cent	Inhibitor
8-27-32	Henley Oil Co.	500	15	
8-29-32	Pure Oil Co.	1000	15	
8-29-32	Chippewa Oil & Gas Co.	5 cbys.	15	
8-30-32	Pure Oil Co.	1000	15	
8-30-32	" " "	1000	15	
8-30-32	Shoup Oil Co.	1000	15	
8-30-32	Ohio Prod. & Ref. Co.	1000	15	
8-31-32	Michigan Gas & Oil Co.	1000	15	
8-31-32	Mammoth Pet. Co	1000	15	
8-31-32	Pure Oil Co.	1000	15	
8-31-32	" " "	1000	15	
8-31-32	The Stanolind Oil & Gas Co.	1000	15	
8-31-32	" " " " "	1000	15	
9- 2-32	Wittmer Co., McKenzie	1000		92 gal. arsenic Pure Oil
9- 2-32	Sias Oil Development Co.	1000		
9- 2-32	Pure Oil Co.	1000		36 gal. arsenic Misc.
9- 2-32	Stanolind Oil & Gas Co.	1000		
9- 2-32	Pure Oil Co.	1000		40 gal. mercaptan base + 40= eq chloride—Pure
9- 2-32	" " "	1000		
9- 3-32	" " "	1000		
9- 4-32	" " "	1000		142 gal. mercaptan base + 142= eq chloride—Misc.
9- 4-32	" " "	1000		
9- 6-32	Michigan Oil & Gas Co.	1000		56 gal. mercaptan base + 56= eq chloride (2 tank cars) (9-2-32, 9-30-32)
9- 6-32	Stanolind Oil & Gas Co. (David =6)	1000		
9- 6-32	Ohio Prod. & Ref. Co.	1000		
9- 6-32	Braden & Saunders	1000		
9- 7-32	Stanolind Oil & Gas Co. (David =3)	1000		
9- 6-32	Pure Oil Co.	1000		
9- 6-32	" " "	1000		
9- 3-32	Shoup Oil & Gas Co.	1000		
9- 7-32	" " " "	1000		
9- 7-32	Pure Oil Co.	1000		
9- 8-32	" " "	1000		
9- 8-32	Sias Oil Development Co.	1000		
9- 9-32	Stanolind Oil & Gas Co. (Davis =6)	1000		
9- 9-32	Stanolind Oil & Gas Co. (Davis =2)	1000		
9- 9-32	Pure Oil Co.	1000		
9-10-32	Simrall Refining Corp.	tank car		
9-10-32	Pure Oil Co.	1000		
9-11-32	" " "	1000		
9-12-32	Stanolind Oil & Gas Co.	500		
9-12-32	" " " " (Davis =4)	1000		
9-12-32	Pure Oil Co.	1000		

Plaintiff's Exhibit 12

Date	Oil Company	Identification Gals.	Per Cent	Inhibitor
9-14-32	Bunks White et al.	1000		
9-13-32	The Wittmer Co. (Smith #2)	1000		
9-13-32	Hewitt Oil Co. (Hewitt #1)	1000		
9-13-32	Pure Oil Co.	1000		
	(Page missing from book—about 32,000 gals. of acid)			
9-26-32	Pure Oil Co.	1000		
9-27-32	Stanolind Oil Co. (McLaughlin #7)	1000		
9-28-32	Stanolind Oil Co. (Ross #1)	1000		
9-27-32	Pure Oil Co.	1000		
9-28-32	" " "	1000		
9-28-32	" " "	1000		
9-30-32	Dow—Muskegon, Mich.	tank car		
9-29-32	Pure Oil Co.	1000		
9-29-32	Stanolind Gas & Oil Co.	1000		
9-29-32	Sias Oil Devel. Co. (Carpenter #2)	1000		
9-30-32	Reed Oil Co.	1000		
9-30-32	Pure Oil Co.	1000		
9-30-32	Thompson Oil Co. (Snyder Lease)	1000		
9-30-32	Stanolind Oil & Gas Co.	1000		
10-1-32	Pure Oil Co.	1000		128 gals. arseni
10-2-32	" " "	1000		acid
10-3-32	Dow—Muskegon	1000		(10-1-32/10-31-3
10-5-32	Pure Oil Co.	1000		
10-6-32	Dow—Muskegon	tank car	15	
10-5-32	Pure Oil Co.	1000		
10-6-32	" " "	1000		
10-7-32	" " "	1000		
10-7-32	Gordon Oil Co. (Skinner #5-B)	1000		
10-8-32	Dow—Muskegon	tank car	15	
10-8-32	Pure Oil Co.	1000		
10-8-32	" " "	1000		
10-11-32	" " "	1000		
10-12-32	Dow—No. Baltimore, Ohio	500		
10-13-32	Sias Oil Co. (Carpenter #3)	1000		
10-13-32	Pure Oil Co.	1000		
10-13-32	" " "	1000		
10-14-32	" " "	1000		
10-14-32	" " "	1000		
10-15-32	George Hemmerick	2		
10-15-32	Pure Oil Co.	1000		
10-15-32	" " "	1000		
10-18-32	Bowling Green, Ohio	1000		

Plaintiff's Exhibit 12

Date	Oil Company	Identification Gals.	Per Cent	Inhibitor
10-16-32	Pure Oil Co.	1000		
10-16-32	" " "	1000		
10-17-32	" " "	1000		
10-20-32	Skinner #2	1000		
10-19-32	Pure Oil Co.	1000		
10-20-32	Pure Oil Co.	1000		
10-22-32	E. J. Henderson	1000		
10-21-32	Pure Oil Co.	1000		
10-21-32	" " "	1000		
10-23-32	" " "	1000		
10-23-32	" " "	1000		
10-24-32	Otway Well No. 1 (Porter Twnsp.)	1000		
10-24-32	Mellon & Pollock (Lynch #1)	1000		
10-25-32	Pure Oil Co.	1000		
10-25-32	Well #3 (B & O Lease)	500		
10-25-32	Well #3 (Hartman Lease, Ohio)	500		
10-20-32	F. Stiltzreid #1	1000		
10-25-32	Wittmer Co. (Smith #1)	1000		
10-26-32	Pure Oil Co.	1000		
10-26-32	" " "	1000		
10-27-32	" " "	1000		
10-27-32	" " "	1000		
10-31-32	Dow—No. Baltimore, Ohio	tank car	15	
10-29-32	Pure Oil Co.	1000		
10-30-32	" " "	1000		
10-31-32	Stepleton (J. S. Braden)	1000		
10-31-32	Pure Oil Co.	1000		
11- 1-32	Pure Oil Co.	1000		
11- 2-32	" " "	1000		
11- 3-32	" " "	1000		
11- 3-32	" " "	1000		
11- 4-32	" " "	1000		
11- 4-32	" " "	1000		
11- 5-32	" " "	1000		
11- 2-32	Sias Oil Devel. Co. (Carpenter #3)	500		
11- 4-32	Herring #1	1000		
11- 4-32	Ohio Prod. & Ref. Co. (Epple #2)	1000		
11- 4-32	Braden & Saunders (Stapleton #2)	1000		
11- 7-32	Mich. Oil & Gas Co.	1000		
11- 8-32	R. O. Malcolm	1000		
11- 9-32	J. S. Braden & Sanders	1000		
11-10-32	Chippewa Oil & Gas Co.	1000		

PLAINTIFF'S EXHIBIT 13

"SARNIA OIL AND GAS COMPANY, LIMITED
SARNIA, ONT.

June 13, 1932

"Dow Chemical Company,
Midland, Mich., U. S. A.
Gentlemen:

"We understand that you have developed a chemical that is having considerable success in Mt. Pleasant and Muskegon as to increasing the amount of production in the old oil wells there. As this territory here produces from the same formation we would be glad to receive any information you may have at this time and would like to work out some agreement for handling same, whereby it would be both profitable and agreeable to all concerned.

"Trusting to hear from you, we remain,

Very truly yours,
"Bert Wilson"

"THE OHIO PRODUCING & REFINING COMPANY
East Ohio Gas Building
Cleveland
June 17, 1932

"Dow Chemical Co.,
Midland, Michigan.
Gentlemen:

"It has come to my attention that certain tests are being made with muriatic acid in the oil wells in the Mt. Pleasant Field, with the result of increased production. Could you furnish me any information regarding these tests as to whether they are generally successful. I would also appreciate your estimate of the cost of the acid and the method of procedure in treating the wells.

Very truly yours,
"J. E. Schaefer"

Plaintiff's Exhibit 13

"PERKINS BROTHERS, INC.
GRAND RAPIDS, MICHIGAN

June 29, 1932.

"Dow Chemical Company,
Midland, Mich.
Gentlemen:

"We understand that you are manufacturing an acid which is claimed to increase the production of oil wells, after same has dropped to a low figure.

"We have an interest in several wells in Michigan, which at present are producing from the Traverse and Dundee formations.

"We are also interested in a number of wells in Kentucky, part of which are producing from sandstone formation, and the others from a lime, or coniferous formation, which, as we understand it is similar, if not identical with our Michigan Traverse and Dundee.

"We should appreciate hearing from you as to the amount of acid necessary, and the cost of same, and whether you treat the wells yourselves, or if this can be done by the caretaker on a lease.

"We should also like to have you advise what success you have met with so far.

Yours truly,
"Perkins Brothers, Inc.
By G. W. Perkins, Jr.
Per E. J. R."

"Madisonville, Kentucky, July 6, 1932

"Dow Chemical Company,
Midland, Michigan.
Gentlemen:

"Attached hereto is a clipping from the Louisville Times which appeared last night. It is of particular interest to me because I own two leases in this county upon which are thirteen wells eight years old.

"The production is found at approximately 500' in the 'Finnie sandstone' (Tradewater formation—Pottsville age) of Coal Measure age (Allegheny-Pennsylvania). Casing-head elevations do not show any particular structure and indications point to a lenticular condition of the sand. The wells started off with an average flush production of 50 barrels per day but have now declined to less than one barrel per day each. Not much gas was present with the oil. The sand varies in thickness from five to twenty feet.

"Since the production has now declined to the point where they must either be abandoned or means taken to improve the production I am earnestly interested in any process which holds some promise of increasing the production.

"I would appreciate having more complete information about your process, the cost of treating wells, the royalty for using the process, the success you have had with it, etc. I shall be glad to experiment with the process under your direction in any manner your experience may dictate.

Yours very truly,

"William E. Schwartz"

(Newspaper Clipping)

"CHEMICAL FIRM FINDS NEW WELL TREATMENT

"Midland, Mich., July 5, 1932—Dow Chemical Company has discovered a new treatment for oil wells, which, it claims, has increased production in the Midland-Isabella fields since its introduction.

"By injecting acid into oil-bearing sand, chemists for the company claim, they have increased the porosity of the strata."

Plaintiff's Exhibit 13

"STANOLIND OIL AND GAS COMPANY
Tulsa, Oklahoma

July 12, 1932

"Dow Chemical Company
Midland, Michigan
Gentlemen:

"We understand that your Company has been furnishing an acid for use in the Mt. Pleasant Oil Field for reaction on the lime producing formation for increasing oil recoveries.

"Will you please advise us just what this acid is and quote our Purchasing Department prices on same f.o.b. McCamey, Texas.

Yours very truly,
"G. S. Bays"

"AMERICAN PIPE & STEEL CORPORATION, LTD.
Alhambra, California

July 15, 1932

"Dow Chemical Company,
Midland, Michigan.
Gentlemen:

"From an article published in the local newspaper in Pawtuckett, R. I., we learn that you have a chemical treatment for oil wells. The writer being interested in quite a few oil properties would appreciate having information on it.

Yours very truly,
"Jack Lane"

Plaintiff's Exhibit 13

"THE NATIONAL REFINING COMPANY
Cleveland, Ohio, U. S. A.

July 15, 1932

"Dow Chemical Company
Midland, Mich.
Gentlemen:

"We understand that you have perfected a chemical powder for use in crude oil wells for increasing production and that it has been tried out successfully in some of the oil fields in Michigan.

"We would like to have any information you can give us on the subject, and would appreciate your advice as soon as possible.

"I might add that we have asked the Grasselli Chemical Company in Cleveland if they know anything about such a chemical but they state they have not been advised of anything along these lines.

"Possibly the information that has reached us is not based on facts. At any rate, we would like to have you advise us.

Scientific Refining
"The National Refining Co.
"S. A. White
"Purchasing Agent"

"INDIAN TERRITORY ILLUMINATING OIL COMPANY AND SUBSIDIARY COMPANIES
Oklahoma City, Oklahoma

July 25, 1932.

"The Dow Chemical Co.,
Midland, Michigan.
Gentlemen:

"We understand that producers in the Midland field are using a considerable quantity of acid after these wells are completed. We are wondering whether or not the use of this acid might be warranted in other areas of the

United States, particularly with reference to some areas in Oklahoma. In order to reach any conclusion, we would ask that you furnish us the analysis and manner of handling Dowell Acid; the approximate quantities required; and the results of applying acid.

"Thanking you in advance for your kindness in this matter, I am

Yours very truly,
C. O. Rison
"Gen. Supt., Prod. Dept."

"UNION OIL COMPANY OF CALIFORNIA
Santa Fe Springs, California
August 10, 1932

"Dow Chemical Company
Midland, Michigan
Gentlemen:

"I today came upon an advertisement in the 'Oil Weekly' for Equipment for the Field, in this same advertisement was an article mentioning a recent development of an Acid Solution to clean out old wells and stimulate production. The trade name of this product being 'Dowell.'

"I will appreciate receiving complete information regarding this product as I am very interested.

"Thank you in advance for this courtesy.

Very truly yours,
F. W. Lake
"General Superintendent"

Plaintiff's Exhibit 13

"EMPIRE OIL & REFINING CO.
El Dorado, Kansas

August 19, 1932.

"The Dow Chemical Company,
Midland, Michigan.
Gentlemen:

"It is reported your firm has a specially prepared hydrochloric acid solution for treating limestone oil wells.

"Will you kindly supply us with data relating to results obtained in your area by treating with this solution, the action of the solution on pipe, method of application, prices, etc.

"Yours very truly,
"Geo. F. Berry, Jr.
"Resident Geologist"

"GULF PRODUCTION COMPANY
Fort Worth, Texas

August 30, 1932

"Dow Chemical Company,
Midland, Michigan.
Gentlemen:

"I have read with interest the account in the Oil Weekly of August 29th of your treatment by means of acid of a well in the Dundee limestone in Midland County, Michigan.

"Will you kindly let me have as much detail as consistent concerning this process? We have quite a number of wells in limestone pay formations, chiefly of Permian age but of very similar chemical characteristics to the ordovician, and therefore, such treatment as mentioned in the Midland County well is of interest to us.

Yours very truly,
"H. A. Melat."

Plaintiff's Exhibit 13

"SHAPPELL OIL COMPANY
Wichita Falls, Texas
August 31, 1932.

"Dow Chemical Co.,
Midland, Michigan.
Gentlemen:

"Please send me any literature or information you have on the product known as 'Dowell' such as you used in the treating of the Walter L. McClanahan Inc., Schaffer No. 1 Well, in Midland County, Greendale, Michigan.

"Conditions here are such that we need something of this nature very badly. If it is successful I will be glad to represent you in this area.

"I have been a representative of Petroleum Treating Compounds here for three years and know personally every producer who might be in the market for such a product as yours.

"Hoping to hear from you in the near future and trusting that we may be able to work out something to our mutual advantage, I am,

"Yours very truly,
(Signed) "Dale Shappell"

"HERCULES POWDER COMPANY
Wilmington, Delaware
September 2, 1932.

"The Dow Chemical Company,
Midland, Michigan.
Gentlemen:

"We have noted your advertisements regarding a method of treating oil wells with an acid to increase the flow of the well.

"We would appreciate it very much if you would give us details regarding this method of treating oil wells to increase their production.

"Very truly yours,
J. Barab, Manager
"Service Division."

Plaintiff's Exhibit 13

"CONTINENTAL OIL COMPANY
Los Angeles
September 12, 1932

"Dow Chemical Company
Midland, Michigan
Gentlemen:

"I read with interest an account in the Oil Weekly, August 29, issue, Page #57, describing results of acid treatment on a producing well. I would appreciate having more information on this experiment; also whether the chemical used is recommended only for limestone formation or could be used in California Fields.

Very truly yours,
"M. N. Phillips"

"CENTRAL UTILITIES CORPORATION
New York, N. Y.
September 12, 1932

"Michigan Oil Journal
Blanchard, Mich.
Gentlemen: Att. Mr W. D. Garvin

"In the issue of your paper—September 6, 1932, I have read an article headed 'Dowell Acid Saves Semi Wildcat Well.' In said article it says, 'the treating of the well by the Dow process, however, and its intendant flow of crude, awakened operators to the full realization of the value of the Dowell acid in 'doster wells.'

"Will you be kind enough to let me know something about this process and how it is used.

"Thanking you in advance for any information you can give me, I remain

Yours very truly,
L. Adam
H."

Plaintiff's Exhibit 13

"CRYSTAL OIL REFINING CORPORATION
Shreveport, La.
September 12th, 1932.

"Dow Chemical Co.
Midland, Mich.
Gentlemen:

"We are considerably interested in an article that appeared recently in The Oil Weekly in which it stated that a new chemical discovered by your company had been used with success in increasing the production from a pumping well near Midland, Mich.

"It will be appreciated if you will let us hear from you describing the use of this chemical, and the price of same, as we have some settled production in this territory that we could probably help by its use.

Yours very truly,
"A. J. Ahlum
"Assistant Secretary"

"JO H. CABLE
Petroleum Engineer
Wichita Falls, Texas
September 12, 1932.

"Dow Chemical Co.,
Midland, Michigan.
Gentlemen:

"Mr. Frank Maire of Lima, Ohio, has told me of your acid treatment of lime wells, and I am very much interested in this development.

"Kindly send me all available information and advise me cost of chemical for 600 to 1100' wells delivered to Wichita Falls, method of application, recommendations, etc.

"After making some tests on my own production, I would be interested in handling the acid treatment in this area if a mutually agreeable arrangement can be made.

Yours very truly,
"Jo. H. Cable"

Plaintiff's Exhibit 2

"R. H. BROWNLEE LABORATORY
Research and Consultation
Pittsburgh, Pa.

Sept. 17, 1932.

"Dow Chemical Company,
Midland, Michigan.
Dear Sirs:

"A client of ours is desirous of trying Acid treatment to increase the flow of oil in some of his wells, and I understand you make and sell an inhibitor to prevent action of the acid upon the pipe, etc.

"If my information is correct, will you kindly advise prices on this material and full particulars as to its use, quantities required, etc. Also send C.O.D., a few pounds for laboratory use in tests.

"If there is any literature available, such as journal articles, patents, etc., shall appreciate having reference thereto.

Very truly yours,
"R. H. Brownlee Laboratory.
"R. H. Brownlee"

"THE CALIFORNIA COMPANY
Dallas, Texas

September 20, 1932

"Dow Chemical Company
Midland, Michigan
Gentlemen:

"We have noted with interest a news item appearing in the Oil Weekly of August 29th, concerning the use of an acid to increase the production in a limestone well drilled by a Mr. Walter L. McClanahan in Midland County.

"Our Company is a producer in West Texas in which territory practically all the production is had in limestones and where, in wells that show for small producers, it is a practice to shoot the producing horizon with nitro-glycerine in order to improve the production.

"If details concerning the treating of the above mentioned well are available we would greatly appreciate it if you would furnish them to us in order that we may study this method in connection with our own operations.

Yours very truly,
The California Company
"By R. H. Morrison"

"UNION CRUDE OIL CORPORATION
Oklahoma City, Oklahoma
September 23, 1932

"Dow Chemical Company,
Midland, Michigan.
Gentlemen:

"I am informed that in the Mt. Pleasant field of Michigan that often times when there is no amount of fluid in their lime holes that they are using an acid to open the pores of the formation.

"We are drilling a well in the Zwolle, La. field and while we have a slight show of oil (about a barrel a day) we are unable to get any oil to speak of out of the hole. This formation being a very hard chalk, we thought perhaps a treatment of acid might tend to open the formation and we might get some kind of a small well. Our hole is perfectly dry and we have approximately 450 feet of 4⅞" liner in the hole. The show that we do have is coming from some place in this 450 feet of liner but we don't know exactly where as there was no perceptable change in the formation at that depth.

"Would thank you very much to give us information as soon as possible on what kind of acid to use and the closest point to Zwolle, La., the same might be shipped from (Zwolle is 80 miles south of Shreveport).

"We are at present matking (making) about 20 feet of additional hole which will still leave us in chalk formation.

"Would appreciate a reply by return mail.

Yours very truly,
"(Signature illegible)"

Plaintiff's Exhibit 13

AIR MAIL

"CAPITAL DRILLING, INC.
Columbus, Ohio
September 26, 1932

"The Dow Chemical, Inc.
Midland, Michigan
Gentlemen:

"We should like some information on the acid treatment for oil wells in the Niagara Lime which you people furnish.

"We have a number of wells which we are getting ready for some such treatment and other wells which will need this same treatment in the near future.

"We are interested in getting full details about this acid treatment: would it be necessary to pull the 2" tubing; how do you put the acid in the well; how much material would it take for each well, do you deliver and instruct the operations of this treatment?

"What would our price be on 500-gallon lot?

"Would appreciate an immediate reply as we are rearranging our work in the oil fields at the present time to make some such test and would be willing to try your product on one of the wells if your proposition is in line.

Yours very truly,
Capital Drilling, Inc.
"C. W. Blacksten
Secy-Treas."

"LAUGHNER OIL AND GAS CO.
South Heights, Pa.
September 27, 1932

"Dow Chemical Company,
Midland, Michigan.
Gentlemen:

"We noticed a news article in the Oil City Derrick about the success that is being had by the use of an acid manufactured by your Company for the purpose of accelerating the production of oil and gas from wells.

"We would be pleased to have a descriptive circular dwelling upon the nature of this acid, together with its method of use—Also prices.

Very truly yours,
Laughner Oil & Gas Company,
"By John C. Bander"

"BRADFORD MOTOR WORKS
Bradford, Pa.

Sept. 29th, 1932.

"Dow Chemical Company,
Midland, Michigan.
Gentlemen:

"We have learned that you manufacture a compound which has been used successfully in cleaning out old wells in the Michigan oil fields.

"Some of our customers in this field are interested, and we should like to have you inform us as to this material and what it is expected to accomplish.

Very truly yours,
Bradford Motor Works,
"S. H. Johnson
Secretary."

"ANACONDA KEVIN OIL COMPANY
312 East Park Avenue
Phone 633
Anaconda, Montana.

Oct. 1st, 1932.

"Dow Chemical Co.,
Midland, Michigan.
Gentlemen:—

"Notice write up in the Montana Oil & Gas Journal, regarding Acid treatment for Oil Wells.

"Kindly advise price? Has anybody used this in Montana?

"Any information you will give will be appreciated.

Yours very truly,
"F. M. Davidson"

Plaintiff's Exhibit 13

"UNITED STATES
"DEPARTMENT OF COMMERCE
BUREAU OF MINES
Box 1207
Shreveport, La.

October 8, 1932

"The Dow Chemical Co.
Midland, Michigan
Gentlemen:

"In the August 29, 1932, issue of the Oil Weekly, page 57, I notice an account of the increasing the oil production from a limestone reservoir, by the use of acid. I was very interested in this article and am wondering if you have any literature regarding the procedure and the kind of acid and amounts used in these experiments.

"Any literature or material you have would be appreciated.

Very truly yours,
"R. E. Heithecker
"Petroleum Engineer"

"C. E. DAUGHERTY & CO.
Owensboro, Ky.
Norman, Oklahoma, October 10, 1932

"Dow Chemical Company
Midland, Michigan.
Gentlemen:

"My attention has been called to the success of acid treatment of wells in the Central Michigan field as recorded in the Oil Weekly. Prof. H. C. George, Director of the School of Petroleum Engineering of the University of Oklahoma, has asked that I investigate the process and prepare a paper covering it.

"I have been unable to find references on this subject in the files of the department. I desire rather complete information as regards to; the condition of the wells calling for treatment, the chemical functions and the mechanical

operations of the process itself, production decline data after treatment, and cost of treatment.

"H. A. Barrett of Glasgow, Ky. first called my attention to such treatment and asked if I thought the treatment applicable to wells in the LeGrand pool of Hart County, Ky. At that time Mr. Barrett and associates were planning to treat a few wells in that district. If possible, I would like to have information regarding the results of the treatment of wells in that and/or any other district.

"At the present time I am on leave at the University to finish my undergraduate work in petroleum engineering. In February my work will be completed and I will return to my position as engineer for C. E. Daugherty of Owensboro, Ky. My employer has production in most of the lime areas through Kentucky and some in southeastern Indiana. If the process seems applicable to the declining production in any of these areas I will recommend it to my employer.

"Realizing that the data I request is rather voluminous I thank you in advance.

"Very truly yours,
"W. B. Heck, Jr."

"447 Chautauqua Ave.,
Norman, Oklahoma."

"JOHN A. KAY
Petroleum Geologist
Wichita Falls, Texas

October 14, 1932

"Dow Chemical Company
Midland, Michigan
Gentlemen:

"The current issue of the Oil Weekly carried a news item from Mount Pleasant, Michigan, in which there was a brief account of the results of treating the producing horizons in oil wells with acids. The article stated that your company had introduced this idea to the oil fields.

"Since this news appeared I have had a number of inquiries from clients asking for information on this process.

Some of these men are anxious to try the acid treatment on their own properties.

"If your company is distributing these acids and has information as to costs, methods of application or other pertinent details, I would be pleased to receive this information from you.

Yours very truly,
"John A. Kay"

"CAMBRIDGE GAS COMPANY
and
"HARVARD GAS COMPANY
Charleston, W. Va.

October 17, 1932

"Dow Chemical Company,
Midland, Michigan.
Gentlemen:

"Attention: Research Department.

"It has come to our attention that in the Saginaw oil field in Michigan you have used an effective chemical to dissolve lime which does not attack the pipe lines. We are much interested in securing details from you to see if this process would be at all applicable in the Berea Sand of this section.

"Our Berea ranges from 20′ to 26′ and of course the porosity varies greatly in different sections. While we have never made any chemical tests of our sands to determine the lime content, often in drilling sand we find lenticular strata which to the eye appears to be limestone. The more porous the formation the greater the amount of stone, which seems to be lime, ordinarily speaking.

"We operate about twenty thousand acres and have approximately eighty oil and gas wells, all in the Berea sand. Most of the wells were shot with thirty quarts of nitro-glycerin from 2′ to 12′ in the sand.

* * * * * *"

Plaintiff's Exhibit 13

"AMORY PETROLEUM CORPORATION
Amory, Miss.

November 4, 1932.

"The Dow Chemical Company,
Midland, Michigan.

Gentlemen:

"We are just in receipt of a letter from the State Geologist of the State of Michigan, giving us various information with regard to the use of hydrochloric acid in increasing open hole flows of both oil and gas wells, and in this letter they refer us to your company.

"The Amory Petroleum Corporation owns what is known as the Amory Gas field. We have four producing wells, producing from what we believe to be Bargor formation. Two of the wells produce approximately 7,000,000 cubic feet of gas per day, from a depth of 2400 feet, and two other wells only produce from 200,000 to 400,000 within a quarter mile from the two larger wells. Hydrochloric acid tests on the producing sands show considerable lime reaction, and our Carter No. 2 well, which produces only 200,000 cubic feet of gas per day, is located only 590 feet north of our No. 1 well, producing 7,000,000. The Rock Pressure of the area is approximately 400 pounds.

* * * * * *

"We have been advised that your company were sending out representatives thruout the country on this new form of testing, and we are wondering whether or not you are in position to quote us prices regarding the total cost of making such tests on our wells. If you are a representative who is working close to this territory, we believe it would be to your interest to have him come into Amory, and go over the matter with us, as there is a large field for your operations here.

Very truly yours,
"F. P. Borden
"Secretary"

Plaintiff's Exhibit 13

"LONE STAR GAS COMPANY
Dallas, Texas

November 5, 1932

"Dow Chemical Co.,
919 Jefferson Ave.,
Midland, Michigan.
Gentlemen:

"We have learned from periodicals and other sources of an acid treatment of oil wells which has been developed apparently to a greater degree of efficiency and perfection in Michigan than in other fields where experiments are now being started by various companies.

"We are very much interested in the proposition and our information is that your company participated in the early development of the proposition in the Michigan territory. I believe, also, there have been some other companies that have since brought out some chemical compositions which are supposed to produce the same results as the composition that you developed in the Michigan field, and perhaps in other fields. As we are very much interested in the entire matter, I am writing to you for such information as you can give us with regard to the methods used, also with regard to whether or not the chemical composition which you developed is marketed in this part of the country, and also whether you have found that different chemical compositions are more adaptable to different geological formations. I find that quite a few companies have started making some tests in this section of the country, but so far as we can learn they are without the exact information which seems to be necessary for an intelligent consideration of the entire matter, and as we are completely without technical information with regard to the whole matter it has occurred to me to write to you in the hope that you can at least give us a lead on some information that might be helpful; of course, with the idea that we would show our appreciation for such information as you give us in the way of reciprocity if such a thing is feasible. We have no information whether you are doing anything towards selling

your product in this part of the United States or cooperating with producers in the way of giving them aid or information, such as I believe you did in the Michigan field.

"We would be very glad indeed to hear from you in regard to the matter.

Yours very truly,
"F. L. Chase
R."

"TEXAS PACIFIC COAL AND OIL COMPANY
Fort Worth, Texas
November 8, 1932

Dow Chemical Company
Midland, Michigan
Gentlemen:

"We understand that you manufacture an inhibitor for the use of hydrochloric acid in oil wells, and that you also undertake the treatment of oil wells.

"Will you kindly advise your terms and prices for such work and also if you are selling the inhibitor separately from the acid, and what your charges are for this material?

Very truly yours,
Texas Pacific Coal and Oil Company
"By E. R. Lederer"

"BROWN TOOL COMPANY (Inc.)
Breckenridge, Texas
November 15, 1932

"Dow Chemical Co.
Midland, Michigan.
Gentlemen:

"I understand that you hold a patent on the treatment of oil wells by the introduction of acid as being practiced here by the Independent Torpedo Co. Having been located in this field since 1919, I am interested in anything that increases the flow of wells, and am conducting a series of laboratory tests in preparation to developing a suitable

process, if I can not make suitable arrangements with someone already owning the rights on such process. I would be very glad to have a letter from you together with a copy of your patent, stating whether you would be interested in a royalty contract, and quoting me on Muriatic Acid, giving gravity of same.

"In your reply, whether favorable to a royalty contract or not, I ask you kindly that you do not fail to give me the number and date of your patent.

"Relating to the possibility of a royalty contract, it will be of interest to you to know that the writer has been a member of the American Society of Mechanical Engineers for a good many years and for several years was a member of the American Society of Mining and Metallurgy, as well as holding a full membership in the Society of American Military Engineers.

"The Brown Tool Company, due to its charter, could not be interested in this proposition, but arrangements will be made that the fulfillment of any contract would be guaranteed by them. I own 97% of the stock of the company.

"Hoping to have an early reply, I am

Yours very truly,

"C. H. Brown

"(Pres. Brown Tool Co.)"

"SHELL PETROLEUM CORPORATION

St. Louis, Mo.

November 28, 1932

"Dow Chemical Company,
Midland, Michigan.
Gentlemen:

"We would be interested in receiving such information as you are prepared to give regarding the use of chemicals for cleaning oil wells of calcareous material, and for solving paraffin problems where these have developed in casing or tubing of wells or in the bore hole.

Yours very truly,

"Shell Petroleum Corporation.

"By G. S. Rollin

Vice-President Production.

Plaintiff's Exhibit 13

"SIMMS OIL COMPANY
Dallas, Texas

Nov. 29th, 1932

"Dowell Incorporated,
Midland, Mich.
Gentlemen:

"I noticed in November 28th issue of the 'Oil Weekly' that you have formed your Company for the purpose of manufacturing and sale of a special acid limestone solvent.

"Wish you would furnish us with the detail of this process and what your price for the acid is, say in 1000-gallon lots.

"We have quite a number of lime wells in Texas that might respond to this kind of treatment and for this reason are interested in this process and cost.

Yours very truly,
"Blaine Johnston
"General Superintendent"

"TEXOMA NATURAL GAS COMPANY
Amarillo, Texas

November 30, 1932

"Dowell, Incorporated
Midland, Michigan.
Gentlemen:

"We have been reading with interest your acid treatment of small or abandoned lime oil wells and also in some cases the treatment of lime gas wells. We are not now in the market for any such treatment, but would be pleased if you could furnish us with data of the procedure and technique of your treatment, especially pertaining to lime gas wells.

Yours very truly,
"Ogden S. Jones"

Plaintiff's Exhibit 13

"HUMBLE OIL & REFINING COMPANY
Houston, Texas.

December 1, 1932

"Dow Chemical Company
919 Jefferson Avenue
Midland, Michigan.

Gentlemen:

"We understand you are marketing a chemical compound for use in oil well cleaning work. We would appreciate complete information from you in regard to the manner in which this product is used, and the type of the acid in the compound, and the strength of the solution. We desire this information so that we may determine, should we use this product, the effect it would have on the metal equipment we have in our wells. It is our understanding that this chemical is diluted to some extent before being used in the wells.

"We would also like to have you quote us prices on this product in lots of 300 gallons up to tank cars, f.o.b. Breckenridge, Texas.

"Will you kindly let us hear from you promptly?

Yours very truly,

"Humble Oil & Refining Company
"By J. M. Sitler
General Purchasing Agent"
"J.A.R."

Plaintiff's Exhibit 13

"J AND J PETROLEUM CORP., INC.
Longview, Texas
December 10, 1932

"Sales Department
Dow Chemical Company
Midland, Michigan
Gentlemen:

"We are operating in many sections of the East Texas oil fields and we are coming in contact with many producers who are beginning to be troubled with parafine. Our familiarity with the Michigan field brings to mind that this is one of the troubles that developed in that field, and that your company has developed a chemical for the treatment of wells so affected.

"Do you have a representative in East Texas? If not, do you desire to make such a connection? If so, we would be very glad to represent you and to stock a supply of your chemical and to give it proper advertising and distribution.

"May we hear from you in the near future?

Yours very truly,
"Foley Operating Co.
"By: John Foley
Pres."

"UNITED STATES
"DEPARTMENT OF COMMERCE
"BUREAU OF MINES
December 12, 1932

"Dowell Incorporated,
Midland, Michigan.
Gentlemen:

"I am interested in your chemical processes to increase oil production and wish you will kindly send me your booklet entitled 'How to Increase Oil Production.'

Very truly yours,
"H. C. Miller
"Senior Petroleum Engineer"

"TEXAS GULF COAST PRODUCTION COMPANY
25 Broadway, New York
December 12th, 1932

"Dowell, Inc.,
Midland, Michigan.
Gentlemen:

"Your 'ad' in the Oil & Gas Journal of Tulsa, Oklahoma is interesting and if you have booklets and other data for distribution will be glad to have it mailed to me at the Hotel Portland, Washington, D. C.

Very truly yours,
"James B. Hammond.
"President."

"W. C. McBRIDE, INC.
"THE SILURIAN OIL COMPANY
1226 Olive Street
St. Louis
December 13, 1932

"Dow Chemical Co.,
Midland, Michigan.
Gentlemen:

"I have recently read in the Petroleum World an interesting account of the results obtained by chemical treatment of old wells under your Patent #1877504.

"We are the owners of considerable production from old producing wells in Illinois and Cushing, Oklahoma, and would appreciate your giving us further information in regard to this matter, especially the approximate cost of treating wells under this process and also the results obtained. Many of our wells are producing from lime horizons.

"Yours very truly,
"C. F. Buchner
"Vice-President."

Plaintiff's Exhibit 17

"THE EMPIRE COMPANIES
Bartlesville, Okla.
December 14, 1932.

"Mr. C. E. Clason,
Lassen Hotel,
Wichita, Kansas.
Dear Sir:

"Confirming our conversation of yesterday when you were in this office, with reference to acid treatment of wells for this Company:

"As I understand it, the Dow Chemical Company desires to treat some wells in the Mid-Continent field to determine the benefits which might be expected from this treatment. The Empire Oil and Refining Company has several wells in Butler County, Kansas, producing from lime formation and it is proposed that we permit the Dow Chemical Company to select ten wells for treatment. The Dow Chemical Company will furnish all chemicals, delivered at the well, and will supervise placing them in the wells. The Empire will furnish labor for pulling rods and other miscellaneous work necessary in placing the chemicals in the wells and will pay the Dow Chemical Company only in the following manner: A joint test will be made to determine the oil production of each well before treatment and also a joint test of the oil production of these wells will be made after treatment, and the Dow Chemical Company will receive their payment of $300.00 per well out of one-half of seven-eighths of the increased production only if, as and when produced and marketed by the Empire. In the event that treatment does not increase production as indicated by these joint tests, the Empire will be under no obligation to the Dow Chemical Company.

"Should you desire to enter into an agreement of this kind, please advise and we will have contract prepared and furnish you with more detailed information on our wells.

Very truly yours,
"M. R. Shaffer,
"General Superintendent,
Oil Production."

"J. S. COSDEN, INC.
Okemah, Oklahoma
December 14, 1932.

"Dow Chemical Company,
Midland, Michigan.
Gentlemen:—

"We would like to have you inform us further, than the write-up in the 'Oil Weekly,' as to the manner of treating oil formations with acid. We have a small producer in the Seminole field (Wilcox Sand), as well as some others, that we might figure on your working over.

"After we hear from you, we shall then make a more definite plan.

Yours very truly,
"J. S. Cosden, Inc. of Okla.
"By: M. M. Miller."

"B. V. von Vitanyi
Oberingenieur

"Dusseldorf-OK.,
Niersstrasse 1
December 15, 1932

"Messrs. Dowell Incorporated
Midland, Michigan.
Dear Sirs,

"From your advertisement in 'The Oil Weekly' I read about the development of a new chemical process for the purpose of increasing oil-production.

"Being the representative of the Ingersoll-Rand Co., 11 Broadway, New York, for Germany I am greatly interested in the new process developed by you in view of my close connections to the German oil fields around Hannover.

"Please forward your booklet describing the new method and its adaptability to different oil formations. In case you think the method applicable to European oil fields I certainly would like to join your sales-organization in some form.

"Referring you to Messrs. Ingersoll-Rand Co. for any information you may desire about my person I hope to have an early answer from you.

Yours very truly,
"B. V. Vitanyi"

"R. B. LAING
1130 North Cheyenne
Tulsa, Oklahoma.

December 20th, 1932.

"The Dow Chemical Co.
Midland, Mich.
Dear Sirs:

"A friend of mine who is a representative of the Shell Co. and returned from Michigan recently, informed me that you had a chemical for treating Oil Wells with a lime formation, thereby increasing the production, and which I understand in (is) not injurious to casing or tools. It occurred to me that you might want some one to represent you in Oklahoma or Kansas and push the sale of your chemical. I have been in the oil business a number of years, and know many of the heads of the large companies and am conversant with oil operations. The oil business at the present is in rather a chaotic condition, and some operators may argue that they do not want to increase their production, but they will if it does not cost too much to do so. Should you require a representative, I shall be glad to receive a reply from you, and I can supply you with satisfactory references as to my stability, and honesty &c.

Yours very truly
"R. B. Laing."

Plaintiff's Exhibit 13

"GYPSY OIL COMPANY
Tulsa, Oklahoma.

January 19, 1933.

"Dowell Incorporated,
Midland, Mich.
Gentlemen:

"We have noted with interest the result of acid treatment as applied to oil wells, and the rapid spread of this method of treatment throughout the Mid-Continent area.

"We have in mind the possibility of treating certain of our wells in the State of Kansas, and in this connection would like to know whether or not your company will be prepared to service wells in that area within the near future. If you have a specific plan formulated, we would like to know the date on which your service will be available.

Very truly yours,
"S. G. Sanderson
General Superintendent"

PLAINTIFF'S EXHIBIT 14

"The Midland Republican
Midland, Michigan, Thursday,
June 9, 1932

"TREAT WELLS BY DOW PROCESS
TO JUMP PRODUCTION

"New Acid Injection Said to
Have Increased Stripper
Flow as Much as
10 Times

"Contracting Work in Midland Field

"A new process of injecting acid into oil wells, which is supposed to increase the porosity of the oil bearing sand and result in a heavier flow of oil from wells which have nearly stopped producing, was announced this week by Dow officials. Oil men are showing a keen interest in the process, which they believe would revive old wells, especially since it has been said to produce as much as ten times the original flow in one stripper. The process in no way affects the quality of the oil.

"The idea is an outgrowth of a process developed for increasing the flow of brine wells. Dow Chemical Co. is contracting to treat wells, but does not take any responsibility for results accomplished. The services of an engineer are to be made available for the new work. Robert Quinlan has been placed in active charge of the work through the sales department. The acid used is trademarked Dowell and the process covered by applications for patents.

"Since the commercial use of the acid was decided upon

the GLeeP firm has been the first to contract for its use. According to Laurence W. Lee, an official, one well is being treated while six more are to be given acid in an attempt to bolster production.

"The treatment has been used on a number of wells in the Midland-Isabella field and found satisfactory according to those in active charge.

"Enthusiastic reception by oil men, lease holders and land owners has been given wherever the process and its working have become known. In it, they see possibilities for getting many times the present production from wells, which have practically ceased to be of any value. This may mean the reworking of dozens of sites in the field and stir a new line of activity."

PLAINTIFF'S EXHIBIT 19

INVOICE

HALLIBURTON OIL WELL CEMENTING CO.
Duncan, Oklahoma

March 11, 1935

CHARGE TO C. F. Hilligoss
Box 812
Wichita, Kansas.

1005 A T

Well No. 2-A Farm Isern Sec. 12 Twp. 20 Range 11-w
Depth 3290 Size Casing 2½" Tub. Used 1000 Gal. Acid.
To furnishing acidizing equipment for acidizing above well, 1000 gal. acid used. $225.00

INVOICE No. A-2

PLAINTIFF'S EXHIBIT 20

INVOICE

HALLIBURTON OIL WELL CEMENTING CO.
Duncan, Oklahoma

May 25, 1935

CHARGE Oko Oil & Gas Company 1008 A T
TO Iola, Kansas
Well No. 4 Farm Pinion Sec. 27 Twp. 23 Range 13-E
Depth 1713 Size Casing 6⅝" Used 1000 Gal. Acid
To furnishing acidizing equipment for acidizing above well, 1000 gal. acid used. $186.00

Invoice No. A-4

PLAINTIFF'S EXHIBIT 21

INVOICE

HALLIBURTON OIL WELL CEMENTING CO.
Duncan, Oklahoma

May 25, 1935

CHARGE Oko Oil & Gas Company 1009 A T
TO Iola, Kansas.
Well No. 4 Farm Pinson Sec. 27 Twp. 22 Range 13-E
Depth 1713 Size Casing 6⅝" Used 1000 Gal. Acid
To furnishing acidizing equipment for acidizing above well, 1000 Gal. acid used. $186.00

Invoice No. A-7

PLAINTIFF'S EXHIBIT 23

PURCHASE ORDER

Erle P. Halliburton, Inc.
810 South Spring Street
Los Angeles, Cal.
To Dowell Incorp.,
Shreveport, La.

No. 1234

Please deliver to Bair #2

5-21-34

Quantity	Article	Price
1500 gal.	acid job	$350.00
	Less 10%	35.
		$315.00

Less 2% for cash—

Erle P. Halliburton, Inc.
By Jack Halliburton

PLAINTIFF'S EXHIBIT 26

PURCHASE ORDER

Erle P. Halliburton, Inc. No. 4618
District Office Mansfield, La. Date Oct. 24, 1934
To Dowell Incorp. Address Shreveport, La.
Please deliver below order to Burkett #3

Quantity	Size	Description
1	1500 Gal.	Acid Job

Dowell
Rec'd Oct. 29, 1934
Tulsa, Okla.
Noted by MW.
(Signed) Jack Halliburton

PLAINTIFF'S EXHIBIT 27

No. 37 Dowell Incorporated Order 2081

BULK MATERIAL SALES RECEIPT

District Louisiana Station Many Date Nov. 9, 1934
Received of Dowell Incorporated the following materials in good order on Customer's Order No. 4581 dated Nov. 9, 1934. Burkett #1.

Quantity	Item	Unit Price	Total Price
1000 gal.	Dowel X	$.25	$250.00

Plus Transportation Charges None
Plus Extra for None Containers at None each ———
$250.00

(signed) Chas A. Prince
For Dowell Incorporated

Customer Erle P. Halliburton, Inc.
Billing Address 810 S. Spring St., Los Angeles.
By (Signed) Jack Halliburton

PLAINTIFF'S EXHIBIT 31

This Agreement, made and entered into this 15th day of March, 1934, March 19, A.M., 9/03, by and between Dowell Incorporated, a corporation organized under the laws of Michigan, with its principal office at Midland, Michigan, hereinafter referred to as Seller, and Steen Drilling, Inc., located at 1418 Esperson, Houston, Tex., hereinafter referred to as Buyer, Witnesseth:

Whereas, The Dow Chemical Company is the owner of certain United States Letters Patent for processes to be applied to a producing oil or other deep well to increase the production thereof; said Patents being Numbers 1,325,293; 1,476,747; 1,856,912; 1,877,504; 1,911,446; 1,916,122; and

Whereas, The Dow Chemical Company has also developed other processes and products for the treatment of deep wells for which United States Letters Patent have been applied; and

Whereas, Seller has obtained from The Dow Chemical Company a license to practice the inventions disclosed in said Letters Patent above listed, and has obtained an agreement for licenses to practice the inventions useful in the treatment of wells on which Letters Patent may be obtained by The Dow Chemical Company; and

Whereas, Seller is equipped to supply and transport products developed by The Dow Chemical Company for increasing the production of deep wells, and to supervise and provide facilities for the treatment of deep wells with such products; Now Therefore

Said Seller agrees to sell to said Buyer and said Buyer agrees to purchase from said Seller sufficient Dowell-X and or other materials for the treatment (within the period hereinafter specified) of not less than 2 wells nor more than 2 wells owned, operated or leased by the Buyer and located in certain counties and states as follows: Louisiana, Sabine Parish.

Said Buyer agrees that within thirty days from the

date hereof it will have not less than 2 wells in readiness for treatment and shall, during each thirty days period thereafter until the contract has been completed, have in readiness for treatment not less than .... additional wells.

Seller reserves the right to refuse to treat any well designated by the Buyer which in the opinion of Seller will not satisfactorily respond to treatment by Dowell-X.

Quantity: Seller's representative in charge shall determine the exact quantities of Dowell-X and/or other materials required for such treatment: Provided, however, that the amount shall not be more than 1,500 gallons nor less than 500 gallons per well: And provided further, that if Buyer shall so direct in writing the maximum gallonage herein specified shall be used.

Price: The price for each well to be treated within a twenty mile radius of Seller's nearest distribution station shall be as follows.

Distribution Station	State	Price
Many	La.	$800.00

For wells located beyond such a radius an additional charge of no cents per mile will be made from the distribution station to the well and return.

In case of imposition of additional Federal or State Taxes of any kind, the Seller shall add such additional costs to the price specified herein.

If Buyer shall have over .... wells treated hereunder and shall duly pay Seller's invoices therefor, it shall be entitled to a rebate of .... per cent.

Terms: Net cash ten days.

Package: In tanks or containers to be furnished by the Seller and equipped with apparatus for administering treatment.

Delivery: Buyer shall furnish Seller with a written order for each well to be treated, specifying the time of delivery and giving Seller reasonable notice thereof. Buyer agrees to have the well in readiness for treatment at the time thus specified, and in event Seller shall be delayed in administering such treatment by reason of any act or omis-

sion on Buyer's part, Buyer shall pay to Seller an additional compensation of $5 for each hour, or fraction thereof, that Seller is delayed in administering treatment. Seller shall furnish its own equipment for transporting and applying the Dowell-X and other materials to the well and shall furnish one employee to make said treatment, and the Buyer shall provide all other necessary help. If the highway conditions prevent Seller from reaching the well with its regular motor trucks, then Buyer shall furnish the necessary form of transportation without charge to the Seller.

Seller shall not be held responsible for any default occasioned by war, fire, strike, accident, civil or military authority, or other contingencies beyond its control.

In view of the impossibility of obtaining accurate knowledge with reference to thickness and variations in the underlying rock structures and the uncertainties of determining the exact conditions of any well before and after treatment, Seller makes no guaranty concerning effectiveness of the product or results of its application; nor shall Seller be liable for any damages, consequential or otherwise, which may be occasioned by any such treatment. No verbal agreement or understanding with Seller's representatives not written herein shall affect or vary this contract as herein expressed and which covers all matters agreed upon with reference thereto. This contract shall not be binding upon Seller until approved by its Home Office at Midland, Michigan.

Executed in duplicate and declared binding upon the parties hereto, their successors and assigns.

Dowell Incorporated
By C. A. Prince, Sales Engineer
Seller
Steen Drilling, Inc., Buyer
By Jack Halliburton.

Approved at Midland, Michigan:
Dowell Incorporated
By Sherman W. Putnam.
Secretary.

PLAINTIFF'S EXHIBIT 34

This Agreement, made and entered into this 20th day of April, 1934, by and between Dowell, Incorporated, a corporation organized under the laws of Michigan, with its principal office at Midland, Michigan, hereinafter referred to as Seller, and Steen Drilling Incorporated or Erle P. Halliburton, Incorporated, located at 1418 Esperson Building, Houston, Texas, hereinafter referred to as Buyer, Witnesseth:

Whereas, The Dow Chemical Company is the owner of certain United States Letters Patent for processes to be applied to a producing oil or other deep well to increase the production thereof; said Patents being Numbers 1,325,293; 1,476,747; 1,856,912; 1,877,504; 1,911,446; 1,916,122; and

Whereas, The Dow Chemical Company has also developed other processes and products for the treatment of deep wells for which United States Letters Patent have been applied; and

Whereas, Seller has obtained from The Dow Chemical Company a license to practice the inventions disclosed in said Letters Patent above listed, and has obtained an agreement for licenses to practice the inventions useful in the treatment of wells on which Letters Patent may be obtained by The Dow Chemical Company; and

Whereas, Seller is equipped to supply and transport products developed by The Dow Chemical Company for increasing the production of deep wells, and to supervise and provide facilities for the treatment of deep wells with such products; Now Therefore

Said Seller agrees to sell to said Buyer and said Buyer agrees to purchase from said Seller sufficient Dowell X and/or other materials for the treatment within 12 months, of 10 or more wells owned, operated or leased by the Buyer and located in certain states as follows, such wells to comprise said Buyer's complete and entire acidization requirements during such period and so located: Louisiana, Oklahoma, Kansas, Texas, New Mexico.

Plaintiff's Exhibit 34

Seller reserves the right to refuse to treat any well designated by the Buyer which in the opinion of Seller will not satisfactorily respond to treatment.

Quantity: Seller's representative in charge shall determine the exact quantities of Dowell X and other materials required for such treatment: Provided, however, that the amount shall not be more than 1500 gallons nor less than 500 gallons per well: And provided further, that if Buyer shall so direct in writing the maximum gallonage herein specified shall be used.

Price: The price for each well to be treated shall be as follows: 10% Discount.

BASE PRICE

1000 gallon—oil well treatment	$250.00
1000 gallon—gas well treatment	285.00
500 gallon—oil well treatment	190.00
Two 500 gallon—oil well treatments, same pool, same day (same or separate customers) each	160.00
Additional Dowell X, same well, same day, add per gallon	.20
All above prices are for Dowell X. If Dowell XX is required, add per gal.	.02

For treatments requiring other special products, such as Dowell XF, an additional charge will be made as arranged for in advance of treatment.

Mileage: All prices are based on well location within a reasonable distance from Seller's nearest established treating station. For wells located beyond such a reasonable distance, an additional charge will be made as mutually agreed upon in advance of the treatment.

The price in this contract is based upon Seller's present costs of labor, raw materials, transportation, and manufacture. If any of these costs increase materially from causes beyond Seller's control, Seller shall have the right to make a corresponding increase in the price in this contract, upon giving the Buyer ten days' written notice. If Buyer is un-

willing to accept such increase, it shall have the right to terminate this contract upon giving Seller written notice within ten days after receipt of Seller's notice of increase in price.

In case of imposition of additional Federal or State Taxes of any kind, the Seller shall add such additional costs to the price specified herein.

Terms: 2% cash discount for payment on or before 20th of month following date of invoice. All accounts unpaid sixty days after date of invoice subject to interest charge of 6% per annum from date of invoice.

Package: In tanks or containers to be furnished by the Seller and equipped with apparatus for administering treatment.

Delivery: Buyer shall furnish Seller with a written order for each well to be treated, specifying the time of delivery and giving Seller reasonable notice thereof. Buyer agrees to have the well in readiness for treatment at the time thus specified, and in event Seller shall be delayed in administering such treatment by reason of any act or omission on Buyer's part, Buyer shall pay to Seller an additional compensation of $5 for each hour, or fraction thereof, that Seller is delayed in administering treatment. Seller shall furnish its own equipment for transporting and applying the Dowell X and other materials to the well and shall furnish one employee to make said treatment, and the Buyer shall provide all other necessary help. If the highway conditions prevent Seller from reaching the well with its regular motor trucks, then Buyer shall furnish the necessary form of transportation without charge to the Seller.

Seller shall not be held responsible for any default occasioned by war, fire, strike, accident, civil or military authority, or other contingencies beyond its control.

In view of the impossibility of obtaining accurate knowledge with reference to thickness and variations in the underlying rock structures and the uncertainties of determining the exact conditions of any well before and after treatment, Seller makes no guaranty concerning effectiveness of the product or results of its application; nor shall

Seller be liable for any damages, consequential or otherwise, which may be occasioned by any such treatment. No verbal agreement or understanding with Seller's representatives not written herein shall affect or vary this contract as herein expressed and which covers all matters agreed upon with reference thereto. This contract shall not be binding upon Seller until approved by its Home Office at Midland, Michigan, or its Branch Office at Tulsa, Oklahoma.

Executed in duplicate and declared binding upon the parties hereto, their successors and assigns.

Dowell Incorporated
By R. D. Shaw, Sales Engineer
Seller
Steen Drilling, Inc., or Erle P. Halliburton, Inc., Buyer.
By Jack Halliburton.

Approved at Tulsa, Oklahoma
Dowell Incorporated
By Crawford,
Mgr. Tulsa Branch, Sec'y. Treas.

PLAINTIFF'S EXHIBIT 38

STEEN DRILLING, INC. No. 8029
Duncan, Okla.

Purchase Order Date 3-15-34
Issued to Dowell Inc.
Shreveport, La.
To be delivered to Burkett #1

Quantity	Size	Description	Charge
1500 gal.		acid shot	$602

(Signed) Jack Halliburton

PLAINTIFF'S EXHIBIT 40

STEEN DRILLING, INC. No. 8030
Duncan, Okla.

Purchase Order Date 3-17-34
Issued to Dowell Inc.
Shreveport, La.
To be delivered to Bair #1

Quantity	Size	Description	Charge
1500 gal.		acid job	$601

(Signed) Jack Halliburton

PLAINTIFF'S EXHIBIT 43

STEEN DRILLING, INC. No. 8571
Duncan, Okla.

Purchase Order Date: 4-20-34
Issued to Dowell Incorp.
Shreveport, La. & Tulsa, Okla.
To be delivered to Raymond #1

Quantity	Size	Description	Charge
1500 gal.		Acid Job	$604

(Signed) Jack Halliburton

PLAINTIFF'S EXHIBIT 46

PURCHASE ORDER No. 1201
Erle P. Halliburton, Inc.
810 South Spring Street
Los Angeles, Cal.
To Dowell Incorporated
835 Kennedy Bldg., Tulsa, Okla.
Please deliver to Raymond #1 5-9-34

Quantity	Article	Price
2000 gal.	acid job	$450.00
	Less 10%	45.00
	net	405.00

Also cash discount of 2%.
Erle P. Halliburton, Inc.
By Jack Halliburton

PLAINTIFF'S EXHIBIT 52

Dowell Incorporated

TREATMENT RECEIPT

Order 1128

District Louisiana Station Many Date July 10, 1934

Received of Dowell Incorporated, one oil/gas well treatment as follows:

On Customer's Order No. 5796 Dated 7-10-34 Dowell Treatment No. 444

Location Sec. 21-9-13 Owner Erle P. Halliburton Inc.

County Sabine State La. Well Name G. I. Paul #2

Billing Address c/o Jack Halliburton, Mansfield Hotel, Mansfield

Single Treatment or Yearly Contract Yearly Base Price $450 Discount 10%

Using 2000 gallons Dowell X and the following additional materials, if any, at prices listed

Extra for mileage, if any None

Extra for time loss, if any None

Total billing price $405.00 Less 2% cash discount if paid on or before August 11, 1934.

Customer Erle P. Halliburton Inc.
By (Signed) F. A. Rymer

(Signed) Chas. A. Prince
Dowell Treating Engineer

PLAINTIFF'S EXHIBIT 54

Dowell Incorporated

TREATMENT RECEIPT

Order 1187

District Oklahoma Station Seminole Date 7/24 1934

Received of Dowell Incorporated, one oil/gas well treatment as follows:

On Customer's Order No. Phone Dated 7-23-34 Dowell Treatment No. 435

Location 9-7-4 Owner Erle P. Halliburton

County Pottawatomie State Oklahoma Well Name Pearson #3.

Billing Address Erle P. Halliburton, Maud, Oklahoma.

Single Treatment or Yearly Contract Single Base Price $650.00 Discount 10%

Using 3000 gallons Dowell X and the following additional materials, if any, at prices listed

2000 additional gallons @ 20c per gallon total $400.00

Extra for mileage, if any None

Extra for time loss, if any None

Total billing price $585.00, less 2% cash discount if paid on or before 20th of following month, 1934.

Customer Erle P. Halliburton
By Paul Halliburton

(Signed) R. F. Copus
Dowell Treating Engineer

PLAINTIFF'S EXHIBIT 57

Dowell Incorporated

TREATMENT RECEIPT

Order 1367

District La. Station Many Date 8-15-1934

Received of Dowell Incorporated, one oil/gas well treatment as follows:

On Customer's Order No. 5754 Dated 8-15-34 Dowell Treatment No. 464

Location Sec. 15-9-13 Owner Erle P. Halliburton Inc.

County Sabine State La. Well Name Jackson #1

Billing Address Mansfield Hotel, Mansfield, La.

Single Treatment or Yearly Contract Yearly Base Price $250.00 Discount 10%

Using 1000 gallons Dowell X and the following additional materials, if any, at prices listed

1000 gallons Dowell X @ .20 per gallon $200.00

Extra for mileage, if any None

Extra for time loss, if any None

Total Billing Price $405.00, less 2% cash discount if paid on or before Sept. 20, 1934.

Customer Erle P. Halliburton, Inc.
By Jack Halliburton

(Signed) C. A. Prince
Dowell Treating Engineer

PLAINTIFF'S EXHIBIT 59

Dowell Incorporated
TREATMENT RECEIPT

Order 1674

District Louisiana Station Many Date Sept. 16, 1934
Received of Dowell Incorporated, one oil/gas well treatment as follows:
On Customer's Order No. 9510 Dated 9-16-34 Dowell Treatment No. 505
Location Sec. 9-9-13 Owner Steen Drilling Inc.
County Sabine State La. Well Name A. J. Burkett #B1
Billing address 1418 Esperson Bldg., Houston, Texas.
Single Treatment or yearly contract yearly Base Price $350.00. Discount 10%.
Using 1500 Gallons Dowell X and the following additional materials, if any, at prices listed
Extra for mileage, if any None. Same company as Erle P. Halliburton Inc. Discount as same C. A. P.
Extra for time loss, if any None
Total Billing Price $315.00, Less 2% cash discount if paid on or before Oct. 20, 1934.

Customer Steen Drilling Inc.
By Jack Halliburton

(Signed) Chas. A. Prince
Dowell Treating Engineer

PLAINTIFF'S EXHIBIT 60

STEEN DRILLING, INC.
Duncan, Okla.

Purchase Order No. 9510
Issued to Doweli Incorporated Date 9-16-34
at Shreveport, La.
To be delivered to Burkett #B-1

Quantity	Size	Description	Amount	Charge
1500 gal.		Acid job	$315.00	$608

Less 2% for cash
(Signed) Jack Halliburton

PLAINTIFF'S EXHIBIT 62

Dowell Incorporated
Treatment Receipt Order 1967

District Louisiana Station Many Date Oct. 24, 1934

Received of Dowell Incorporated, one oil/gas well treatment as follows:

On Customer's Order No. 4618 Dated 10-24-34 Dowell Treatment No. 523

Location Sec. 16-9-13 Owner Erle P. Halliburton Inc.

County Sabine State La. Well Name Burkett #3

Billing Address Mansfield, La., Hotel Mansfield, c/o Jack Halliburton

Single Treatment or Yearly Contract yearly Base Price $350.00 Discount 10%

Using 1000 gallons Dowell X and the following additional materials, if any, at prices listed

Extra for mileage, if any None

Extra for time loss, if any None

Total billing price $315.00 Less 2% cash discount if paid on or before Nov. 25, 1934.

Customer Erle P. Halliburton, Inc.
By F. A. Rymer

(Signed) Chas. A. Prince
Dowell Treating Engineer

PLAINTIFF'S EXHIBIT 64

Dowell Incorporated
Treatment Receipt Order 2104

District Louisiana Station Many Date Nov. 14, 1934
Received of Dowell Incorporated, one oil/gas well treatment as follows:
On Customer's Order No. 4588 Dated Nov. 14, 1934 Dowell Treatment No. 535
Location Sec. Owner Erle P. Halliburton Inc.
County Sabine State La. Well Name Burkett #3
Billing Address Mansfield Hotel, Mansfield, La., c/o Jack Halliburton
Single treatment or yearly contract Yearly Base Price $450.00 Discount 10%
Using 2000 gallons Dowell X and the following additional materials, if any, at prices listed:
1000 at $.20 per gal.
Extra for mileage, if any none
Extra for time loss, if any none
Total billing price $405.00 Less 2% cash discount if paid on or before Dec. 20, 1934.

Customer Erle P. Halliburton Inc.
By Jack Halliburton

(Signed) Chas. A. Prince
Dowell Treating Engineer

PLAINTIFF'S EXHIBIT 66

Dowell Incorporated
Treatment Receipt

District Louisiana Station Many Date Dec. 19, 1934
Received of Dowell Incorporated, one oil/gas well treatment as follows:
On Customer's Order No. Telephone Dated Dec. 28, 1934.
Dowell Treatment No. 553
Location Sec. Owner Erle P. Halliburton
County Sabine State La. Well Name Barr #1
Billing Address Los Angeles, Calif., 815 Spring St.
Single Treatment or Yearly Contract Yearly Base Price $250.00 Discount 10%
Using 1000 gallons Dowell X and the following additional materials, if any, at prices listed
Extra for mileage, if any 0
Extra for time loss, if any 0
Total billing price $225.00 Less 2% cash discount if paid on or before Jan. 25, 1935.

Customer Erle P. Halliburton
By F. A. Rymer

(Signed) Chas. Prince
Dowell Treating Engineer

PLAINTIFF'S EXHIBIT 93

OIL CITY DERRICK

Thursday, October 10, 1895

A GREAT DISCOVERY

How the Production of Lima Oil Wells May Be Increased Without Shooting.

Lima, O., Oct. 9.—A new method of increasing the output of oil wells, based on chemical action, has been brought to light, which will have a great influence on the production of oil in the future. It will be of special value to the oil producer. It has already been tested, and has been proven a success.

This method is based on the fact that the oil bearing rock is lime formation, which is readily dissolved, or disintegrated by acids. Hydro-chloric acid is the one preferably used, as it changes 40 per cent by weight of the rock it dissolves, into carbonic acid gas, and the remaining 60 per cent into chloride of calcium. The chloride of calcium is more soluble in water than common table salt, while the carbonic acid gas is readily bound by the water when under pressure.

The oil-bearing rock is made up of hard particles cemented together. This cement is more readily acted upon by the acid than the hard particles, therefore when the acid is pressed back into the rock, it dissolves out that part which binds the rock together; for this reason, when ten or twenty tons of rock are dissolved out, and removed from a well, hundreds of tons of rock have been disintegrated, and new channels formed, causing the rock to give up its oil, which cannot be done in any other way known.

The acid naturally follows the loose rock containing the oil, and wherever it touches the rock it leaves its track of carbonic acid gas and chloride of calcium. The chloride of calcium is taken up by the water, and a channel, or opening remains leading back to the well. By this means oil reas-

ures or pockets can be reached which ordinarily would not be found, crevices or openings in the rock are enlarged; horizontal channels are cut to greater distances, the acid seeking out the porous rock that contains the oil, making it possible for one well to drain a scope of territory that by the usual method would take many wells.

Large quantities of water are used with the acid so that the acid may be carried long distances, and the water be present to take up the rock when it is made soluble. Also the water being under great pressure, binds the carbonic acid gas in large quantities, and again liberates the gas to rush back through the long channels leading to the well, when the pressure is removed by starting the pump. Also by this method pockets or reservoirs can be excavated at the bottom of a well to receive and hold the oil that drains to it, so that small head wells would have to be pumped only once a week, or so, that ordinarily have to be pumped once or twice a day.

At first thought the average mind would conclude that if 10 or 20 tons of acid were put into an oil well it would not be neutralized by the lime rock, and that when re-tubed the tubing and cups would be eaten by the acid. On the contrary, it has been proven by actual tests in a large way that when the acid is pressed back into the rock it is thoroughly used up by uniting with the rock and forming new compounds, carbonic acid gas and chloride of calcium, which are harmless. The chloride of calcium is taken up by the water and is pumped from the well without in any way harming the working barrel or valves, in fact, the acid does its work so completely that not even traces of acid can be found in the water by the most delicate tests known to chemistry. From 50 to 100 barrels of acid are usually used in one well.

In applying this process the tubing and rods are removed from the well, and a one-inch tubing is substituted, reaching down at least to below the casing and usually to the top of the oil bearing rock. This one-inch tubing is coated so that the acid will not affect it, and is termed the

acid pipe. To introduce the acid and do no injury to the casing it is necessary to pack the well off below the casing, which can be done with an ordinary packer; however, in practice, where oil is accessible, it is used to serve as a packer. Some three barrels of acid are put into the well through the acid pipe, then the well is filled outside of the acid pipe and inside of the casing with crude oil, thus, in effect, packing the well off just above the oil bearing rock.

In the average small well the oil bearing rock is usually close, the channels leading to the well are small and the oil that reaches the well is forced into it by the rock pressure, which is generally from a small pressure to 400 or 500 pounds per square inch. In introducing the acid into such rock to open the channels it is necessary to use sufficient pressure to overcome the rock pressure and to carry the acid back into the rock. The pressure necessary for this purpose is had from the hydrostatic column of acid in the acid pipe leading from the top to the bottom of the well, which exerts a pressure of from 700 to 800 pounds per square inch on the rock.

It is sometimes found, where the rock is close and the channels small, that additional pressure to that had from the hydrostatic column has to be employed, then a pump is used to press the acid back into the rock. In such wells, the acid will be driven into the rock very slowly at first, possibly not faster than a barrel per hour; however, as the acid begins to open up the channels, it is received more freely, and at the finish, it will take the acid and water at the rate of six or eight barrels per hour.

Two months ago, a practical test of this process was made on a well on the Crossely farm, owned by the Ohio Oil Company, near Lima, Ohio. There were 65 barrels of acid used in the well on the Crossley farm. The channels in the oil rock in this well, were so tight that even with a pressure of between eight and nine hundred pounds per square inch, the rock would take barely a barrel of acid and water per hour. However, as the acid began to perform its work, the channels in the rock were gradually increased so

that at the finish the rock would readily take up six barrels per hour.

Since doctored, this well has been pumped some 40 days. The oil was increased 300 per cent, and the gas over 400 per cent. The increase has been permanent as the well is holding up.

When it is taken into consideration that with one ton of acid, one ton of rock can be removed, and that the acid will naturally follow the loose, porous rock, and the low price of acid, one can see how easily and cheaply channels can be excavated in the oil bearing rock, extending long distances from an oil well. Any practical oil producer will quickly appreciate the value of such excavated channels.

While this process may seem very simple after the above explanation, yet it has required considerable ingenuity and skill, and a practical knowledge of oil wells, as well as chemical facts to develop the thought, and bring it to its present perfection so that now an oil well can as readily be doctored with acid as it can be torpedoed, and results obtained that cannot be hoped for from the use of glycerine. This method was originated and developed by J. W. Van Dyke, of Lima, superintendent of the Solar refinery, and Herman Frasch, of Cleveland, who are the owners of the patents covering the same. P. B. C.

PLAINTIFF'S EXHIBIT 94

DOWELL INCORPORATED STATISTICS
(November 10, 1932 to 1940 inclusive)

	1932	1933	1934	1935	1936	1937	1938	1939	1940
Personnel[x]	21	33	60	58	90	187	164	209	229
Treating Stations	7	6	11	10	14	22	23	28	26
Pump Trucks	8	11	16	21	37	51	50	53	56
Compressor Trucks	0	0	2	2	2	2	5	4	5
Tank Transports	0	1	8	10	7	23	23	23	23
Tank Trailers	0	3	6	13	29	67	71	71	73
Pick-Ups and Passenger Cars	0	0	1	18	30	74	79	100	112
Well Treatments	59	1121	1988	2144	3057	4764	3850	4241	5522
Number of States in which Dowell operated	3	7	9	11	12	12	14	15	16
	Mich.	M-	M-	M-	M-	M-	M-	M-	M-
	Ohio	O-	O-	O-	O-	O-	O-	O-	O-
	Ky.	K-	K-	K-	K-	K-	K-	K-	K-
		Kan.	K-	K-	K-	K-	K-	K-	K-
		La.	L-	L-	L-	L-	L-	L-	L-
		Okla.	O-	O-	O-	O-	O-	O-	O-
		Tex.	T-	T-	T-	T-	T-	T-	T-
			Ill.	I-	I-	I-	I-	I-	I-
			Mont.	M-	M-	M-	M-	M-	M-
					N.Mex.	N.M.-	N.M.-	N.M.-	N.M.-
					Wyo. W.	W-	W-	W-	W-
						Calif.	C-	C-	C-
							Ind.	I-	I-
							Ark.	A-	A-
								Mo.	M-
									Nebr.

[x]Does not include part time employees

Plaintiff's Exhibit 94

1655

PLAINTIFF'S EXHIBIT 142

Index Card, Carnegie Library, Pittsburgh, Pa.

"Oil City Derrick (Daily), January 14, 1876-1903, September 1, 1909-1929, 1876-1929.

* * * * *

"The most valuable existing record of development of the petroleum industry in the United States. Special attention to markets, field operations, and production."

PLAINTIFF'S EXHIBIT 143

OIL CITY DERRICK, MONDAY MORNING, OCTOBER 28, 1895

OIL NEWS

THE MONTPELIER FIELD

A Decline in the Volume of Active Operations —Price Report of Producers' Committee

Operators are making many comments on the proposed method of "doctoring" wells with hydrochloric acid instead of shooting them with nitro-glycerine, and a large number of them would like to see an experiment with the acid tried in the Hoosier field.

PLAINTIFF'S EXHIBIT 144

OIL CITY DERRICK, SATURDAY MORNING, NOVEMBER 9, 1895

OIL NEWS

ANOTHER ACID TEST

The New Process Tried on a Well in the Findlay District—Field Notes

Findlay, O., Nov. 7.—(Special.)—Another test of the Van Dyke-Frasch method of treating wells with hydrochloric acid has been made, this time on a small well in the Findlay filed. The test was a marked success. The well upon which the experiment was made is owned by the Ohio Oil Company, and is situated on the J. W. Taylor farm, about four miles north of Findlay.

One hundred and eighty carboys of the acid were used in the well, which, before the test, made about 5 bbls. of oil daily. The experiment was made last week, since which time the well has been steadily producing 35 bbls. of oil every day.

PLAINTIFF'S EXHIBIT 145

OIL CITY DERRICK, WEDNESDAY MORNING, JANUARY 15, 1896

OIL NEWS

ACID TESTS

Several additional tests of the method of treating wells with acid have been made recently. A car load of the acid was placed in the Ohio Oil Company's No. 1 well on the Mary Richard farm, located one-half a mile east and one-half mile north of Prairie Depot, O. This well, which is about five years old, was increased from 4 bbls. to 11 by the treatment.

A second test in the Findlay field has not proven a success. The Ohio Oil Company's No. 2 well on the Thos. Cusac farm, located three miles northwest of Findlay, was treated with the acid a short time ago. This well is about nine years old. Its production of about 4 bbls. daily, was not changed by the treatment.

A well owned by A. A. Scott & Co. on the Arnett farm, located about four miles east and one mile south of St. Mary's, O., was also treated. This well was increased from about 11 to 16 bbls.

A well owned by A. A. Scott & Co. on the Metz farm, located three miles east and one-half mile south of Glynwood, O., was treated, and its production was increased from 2½ bbls. to about 11 bbls.

PLAINTIFF'S EXHIBIT 146

OIL CITY DERRICK, THURSDAY MORNING, FEBRUARY 20, 1896

OIL NEWS

ACID TESTS

An Interesting Topic of Discussion Among Oil Producers—Satisfactory Results

Lima, O., Feb. 17—(Special.)—The Van Dyke-Frasch method of treating wells with hydrochloric acid is generally becoming a very interesting topic for discussion among the oil men of Northwestern Ohio and Indiana. The tests that have already been made in different parts of the field have in most cases resulted very satisfactorily. Other tests are being made as rapidly as possible, and the great discovery will undoubtedly soon take rank as one of the most important branches of the oil industry.

The experiments so far have all been made on wells that were small at the outset, or what is worse, played out wells and even dry holes. It would be of great interest to the trade to witness a test made upon a well of fair calibre in a good field.

The well on the Taylor farm, north of Findlay, which was treated last October, has given the best results of any test yet made. It is estimated that the increased production of this well since it was treated, amounts in value to about $3,500. It is interesting to note that a well, situated on a farm just across the road from the Taylor farm, was given a good shot with glycerine at about the same time that the Taylor well was treated with acid, and it is reported that this well has not as yet paid for the shot in increased production. The total cost of the acid treatment is at present about $300 for each well, and it is quite probable that these figures will be considerably reduced when the process has received general use.

Plaintiff's Exhibit 146

The well on the Mary Richard farm, near Prairie Depot, which was increased by the acid treatment from a daily production of 3 bbls. to 12 bbls., is now making about 15 bbls. daily.

The well on the Cusac farm, northwest of Findlay, the production of which was not increased by the acid treatment, will be torpedoed soon. The effects of a shot and the acid ought surely to bring forth an increase in production, provided there is any more oil to be found.

A. A. Scott & Co.'s well on the Arnett farm, east of St. Marys, which was increased from 11 to 16 bbls., has been given a shot and has declined to 8 bbls.

Neely & Co.'s No. 1 well on the Neely & Co. farm, section 16 St. Marys township, Auglaize County, has been treated with acid and its daily production increased from 7 to 17 bbls. thereby.

A. A. Scott & Co.'s No. 1 well on the Longsworth farm, section 8, Washington township, Auglaize county, has also been treated. This well was, and is yet, a dry hole.

A. A. Scott & Co.'s No. 1 well on the Metz farm, near Glynwood, which was increased from 2½ to 11 bbls., is now making between 25 and 30 bbls. daily.

A. A. Scott & Co.'s No. 4 well on the Presser farm, a short distance west of the Metz farm, was increased by the acid process from 7½ to 20 bbls.

Other tests of the acid process are now being made, the results of which will be presented to the trade through the Derrick as soon as possible. P.B.C.

PLAINTIFF'S EXHIBIT 147

OIL CITY DERRICK, SATURDAY MORNING, FEBRUARY 22, 1896

OIL NEWS

THE FINDLAY FIELD

Very Little Work in Progress—Operations Widely Scattered

The Ohio Oil Co. has shot its No. 2 well on the Cusac farm, in Liberty township. This is the well that was unsuccessfully treated with hydrochloric acid a short time ago. It is said that the shot has bettered it considerably, although just how much cannot be estimated at present.

PLAINTIFF'S EXHIBIT 148

OIL CITY DERRICK, THURSDAY MORNING, MARCH 26, 1896

OIL NEWS

PRODUCTIONS INCREASED

Favorable Results Gained by Treating Wells With Hydrochloric Acid

Lima, O., March 24.—(Special.)—The more tests that are made of the system of treating wells with hydrochloric acid for the purpose of increasing the oil production

through the spring up of the rock fissures by the chemical process of disintegration, the more evident does it appear that the method is a success beyond the experimental stage.

That by this process production can be increased where all other methods fail is now an assured fact which the most skeptical would have hard work to disbelieve. What the possibilities of the method are or how great a revolution it may bring about in the oil business in the Trenton rock fields time will best prove. Of course, it is not claimed that oil can be made to flow where wells make no showing, but the promoters of the acid treatment claim to be able to greatly increase the production of wells which have, through age or other causes, fallen off. Wells which are located in good territory but which for reasons which the drill never satisfactorily discloses did not come in as large as their location warranted, will, it is thought, be especially helped by a treatment of hydrochloric acid.

On March 4 Jones & Bell's No. 1 well on the O'Connell farm, one-half mile south and one mile east of Gynnwood, O., Moulton township, Auglaize county, was treated and the results were highly beneficial. The well was five years old, had been shot with 80 quarts when drilled in and started off at 60 barrels. It had gradually dropped off in production until it was doing only six and one-half barrels. Since having been treated with the acid it has been pumping 20 barrels per day, an increase of over 300 per cent.

Remarkably good results were obtained on the same company's No. 5 well on the Beyham farm, in the same township. This well was only three months old and started off at 60 barrels, after having been shot with 160 quarts. It fell off so rapidly that the owners thought it was filled up, but when the tools were run such was not found to be the case, and it had almost been decided to shut the well down, as it was doing only two barrels. It was treated on March 10th and is now doing 45 barrels, an increase which will make quite a difference in the owner's credit balances at the end of the month.

The Sawyer Oil Company's No. 1 on the A. Tinsley farm, section 35, Nottingham township, Wells county, Ind.,

was treated January 27 and although not got to pumping until about the 1st inst., it shows a good increase in production. This well was over two years old, was shot when drilled in with 120 quarts and started off at 15 barrels, but had dwindled down to 1 2/3 barrels. It is now putting 14 barrels into the tank per day.

A. A. Scott & Co.'s No. 1 on the William Hydecker farm, section 1, Salem township, Auglaize county, was treated the last of January, and the production increased from three to six barrels, the smallest percentage of any of the four tests. The well was two years old, had been shot, when drilled in, with 80 quarts, and started off at 15 barrels. The most noticeable effect of the treatment in this well was the increase in the flow of gas, which was formerly quite light, but sufficient to furnish fuel to pump the well.

F. W. B.

PLAINTIFF'S EXHIBIT 149

OIL CITY DERRICK, TUESDAY MORNING, AUGUST 10, 1897

OIL NEWS
Ohio and Indiana
Buckland, Ohio

J. B. Kerr, receiver, has completed his No. 1 well on the William Bice farm, located in section 15, Amanda township, Allen county. The well was dry and abandoned after being treated with hydrochloric acid.

PLAINTIFF'S EXHIBIT 153

GYPSY OIL COMPANY CORRESPONDENCE AND REPORTS

Tulsa, Oklahoma, January 13, 1928.

Mr. R. S. Knappen,
Pittsburgh, Pa.

Assignment No. 38, Salt and Gyp Formations.

Dear sir: Today you are being forwarded by parcel post a sample of tubing from a well in the Glenpool field, externally coated with a gyp formation. This sample was taken from J. Spocogee No. 5 which is a property in the north extension of the Glenpool field in Section 17, Township 18 North, Range 12 East, Map No. 31. About three years ago this well ceased to produce on account of what seemed to be tubing trouble. Crew was assigned to pull tubing and when work was started it was found that tubing could not be raised. Two or three days were spent following out the regular procedure of injecting fresh water and salt water, and I believe gasoline was also used, but tubing could not be removed.

The well was a very small producer and all cleaning out tools of that division were employed on more important wells, and the expense of moving tools to this well was delayed from time to time until November 29, 1927, when the work was started. All tubing has been removed from the hole which was a case of pulling on it until it parted and then fishing it out by sections. We were successful in removing the barrel and anchor as well as the tubing. It was found that 420 feet of the tubing, including the barrel and anchor, were gyped in the same proportion as the sample that you will receive. The barrel and anchor were sent into Tulsa laboratory for investigation and analysis and later a complete report will be made up which will be passed through our Executive Department and will reach the Research Department through the regular channels.

This sample might be termed an extreme case but many similar cases have been experienced in the Glenpool field and a great number of a slighter form. This condition is responsible for an added expense to our operation in District No. 1 and particularly on the properties in the North Glenpool Field, but due to the fact that a careful study has not been made of it and operating expense for which it is responsible segregated, no estimate can be given, but I am sure that it is so serious that it is one problem that we should work on consistently, and if it is impossible to prevent the formation, if some chemical could be found to remove the gyp, it would in many cases avoid the expense of pulling tubing and in other cases of removing the tubing and cleaning out the hole with cable tools.

Yours very truly,

CPD:SG

Tulsa, Oklahoma, February 23, 1928.

Mr. Henry McGraw,
Building.

Assignment No. 38, Salt and Gyp Formations

Dear Sir: In the Glenpool field during the last ten years, precipitated solids have been very noticeable in many of our wells and this is now one of our real operating problems in that pool.

The gyp or salt formation occurs in working barrel, on valves, and on outside of tubing, and evidence obtained by samples of sand from wells reshot shows the same formation deposited on wall of sand. The extent of this condition has not been thoroughly checked as to area or as to the exact number of wells, but it is quite general and in many cases it has been so serious that rods or tubing could not be removed from hole until fished out with tools.

One instance, for example, is Jennie Spocogee No. 5 which has stood inactive for the past three years. This well was a small producer and when the trouble was discovered it was considered that tools being operated could be used on other properties to a greater advantage and the

work was put off from time to time. A short time ago tools were moved into this well and the tubing removed, which required several days. The scale, gyp, or solids on this string of tubing first appeared 21 joints from bottom in a formation 1/64th inch in thickness. From this point to the working barrel, the thickness of scale increased to 1/4th inch. In this well the tubing also showed the formation on interior. Samples of the formation and tubing were sent in to our laboratory where an analysis was attempted, same showing principally carbonates of calcium, magnesium, iron, a trace of barium, and some silica. It was my intention that samples would be prepared and held for your instructions and that the subject would be referred to the Research Department, Pittsburgh. However, in error, the samples of tubing scale and water samples taken from the well were forwarded by express to Mr. R. S. Knappen. This was due to the fact that Mr. Knappen had made inquiries concerning the difficulty and on a previous date had asked for such samples. The samples in question are now in Pittsburgh and have been turned over to Dr. Foote, and I would be pleased if you would address him on the subject.

Further investigation is being carried on by this department but the most active conditions that we have found to this date are on our Jacob Anderson lease on Section 9, Township 17 North, Range 12 East, on the J. P. Rhodes lease in Sections 20 and 21, same township and range, and on the Earl Berryhill South 40 acres, located in Section 9, same township and range. Later, I hope to have a more complete report on the extent of this trouble.

Yours very truly,

C. P. Dimit.

CPD:SG

Plaintiff's Exhibit 153

Tulsa District, Research Problem No. 2.

Dr. Paul D. Foote,
Senior Industrial Fellow,
Mellon Institute of Industrial Research,
University of Pittsburgh,
Pittsburgh, Pa.

Dear Sir: A short time ago, Mr. Dimit's office sent to Mr. Knappen, at Pittsburgh, samples of a deposit which collects in the form of scale at the bottom of tubing strings in the Glenpool field, together with samples of the water from which, apparently, it was precipitated. It was the intention that these samples be sent to you, but through error, they were sent to Mr. Knappen. It is my understanding that these samples are now in your possession.

These particular samples are from Well No. 5 upon the Jennie Spocogee property, in the north extension of the Glenpool. In this well the deposit appeared upon the bottom twenty-one joints of tubing, varying in thickness from one sixty-fourth of an inch at the twenty-first joint, to one-fourth of an inch at the working barrel. Its deposition in this well is rather typical of its appearance in many wells in the Glenpool field, the deposit appearing upon the working barrels, valves, tubing, rods, and presumably the casing. Sometimes its thickness is such as to effectually cement the casing to the tubing. Occasionally, it is impossible to remove the rods and tubing without the use of fishing tools. Its appearance, while not universal, is sufficiently prevalent to present a serious annoyance. Our investigations have not been sufficiently extensive to determine whether the water carrying the undesirable minerals comes from the producing sand, or trickles down from upper formations through breaks in the casing, which in this area, as a rule, is more or less corroded.

It is my hope that you will be able to recommend some solvent, which will remove this deposit, or perhaps some means of preventing its deposition.

Yours very truly,

JDI*D

Plaintiff's Exhibit 153

Pittsburgh, Pa., May 24, 1928.

Mr. Henry McGraw, Vice President,
Gypsy Oil Company,
Box 2044,
Tulsa, Oklahoma.

Subject: Salt and Gyp Formation.

Dear Sir: In further reference to your letter of March 7th, describing Tulsa District Research Problem No. 2 relative to the salt and gyp formation in Well No. 5 on Jennie Spocogee property, Glenpool, this work will be designated under our serial number Ch-17. In a few days I shall submit to you a complete set of our research assignment so that there will be no further difficulty in referring to work in progress at this laboratory.

I enclose a memorandum by Dr. Wescott in which he requests some data relative to operation in the Glenpool.

Yours very truly,

Paul D. Foote,

PDFoote:G Senior Industrial Fellow.

Pittsburgh, Pa., June 1, 1928.

Mr. Henry McGraw, Vice President,
Gypsy Oil Company,
Box 2044,
Tulsa, Oklahoma.

Dear Sir: I enclose a memorandum by Dr. Wescott relative to the removal of scale and gyp formation in the Glenpool field. He will have a complete report on this subject ready in a few weeks but if you desire to try some experiments before that time we shall be glad to send the inhibitor referred to.

Yours very truly,

Paul D. Foote,

PDFoote:G Senior Industrial Fellow

Enclosure.

Plaintiff's Exhibit 153

Memorandum on Scale and Gyp Formation.

It was suggested in a recent memorandum on this subject that a trial be made with muriatic acid to remove the scale deposit in a well of the Glenpool field. While it is probable that no serious damage to the tubing and casing would result it will be possible to practically prevent all action on them by the use of an inhibitor. I, therefore, suggest that if such a trial is to be made the research laboratory be notified far enough in advance so that the inhibitor may be sent together with directions for its use. This will effectively limit the action of the acid to the scale alone, protecting the casing and tubing completely.

B. B. Westcott.

Dr. Paul D. Foote, June 4, 1928.
Mellon Institute,
Pittsburgh, Pa.

Dear Sir: Your letter of June 1st, on the subject of scale and gyp formation in the Glenpool field has been received, with the accompanying memorandum on an inhibitor.

I shall be glad to receive more information about the inhibitor. The casing in Glenpool is old and it seems undesirable to pour hydrochloric acid into the well for even a small amount of corrosion will eat through a thin pipe and admit large quantities of water through the well.

A previous letter asked for additional information, which data is being collected. In that letter I note a reference to the possible use of soda ash. If soda ash is to be used as an inhibitor, will it not result in the precipitation of these carbonates in the bottom of the well? If so, it would obviously plug off the oil sand which would be highly undesirable. As stated, I should be glad to have detailed information about the inhibitor which Doctor Wescott proposes for us.

Yours very truly,

RSK:MG

Plaintiff's Exhibit 153

Pittsburgh, Pa., July 19, 1928.

Mr. Henry McGraw, Vice President,
Gypsy Oil Company,
Box 2044,
Tulsa, Oklahoma.

Dear Sir: Herewith are two copies of a report by Dr. Wescott on the removal of scale and gyp from wells in the Glenpool. I believe that we have found something here well worth giving a careful trial. We have given the matter considerable study and are convinced that treatment cannot injure the well or the producing sand. In fact, as mentioned to you here, it should be very effective for removing gyp from the face of the sand. Certainly if there is enough of the gyp clogged on the tubing the sand must be badly contaminated and the removal of the gyp from the latter will increase production.

The cost estimates of Wescott are based upon very extreme conditions in a well so badly contaminated that it would be impossible to remove several hundred feet of tubing. Naturally if only 50 or 100 feet of tubing were clogged the cost would be proportionately less and I presume that it would not cost over $50.00 to give the face of the producing sand a thorough treatment. We shall await with interest your comments upon this proposition. As a gamble for increased production in this district it looks excellent to me.

Yours very truly,

PDFoote:G Paul D. Foote,

Pittsburgh, Pa.

Mr. Henry McGraw, Vice President,
Gypsy Oil Company,
Box 2044,
Tulsa, Oklahoma.

Dear Sir: Enclosed is a memorandum on scale formation in wells by Dr. Wescott. This comment follows that given in his report sent you earlier. We shall greatly appreciate information relative to the questions listed in this

memorandum; especially we would like several typical gas analyses as described in our letter of May 24th. We wish to know the source of the carbon dioxide. If the oil originally contained large quantities of carbon dioxide it would probably be sufficient to explain the present gyp deposit. This would be shown by copies of gas analyses made when the field was young.

Yours very truly,

PDFoote:G Paul D. Foote.
Enclosure
cc. Mr. F. A. Leovy.

Memorandum on Scale Formation in Wells,
Blaine B. Wescott.

We are sending under separate cover, samples of tubing that were treated with concentrated hydrochloric acid containing different amounts of inhibitors. It is very much easier to visualize the effect of the acid from the specimens than from a table of results. You will readily see from these samples that the attack was nearly negligible in all cases where the inhibitor was used. The original roll marks are still visible in nearly every case.

In the event that a trial is made with this method, there should be a constant supervision over the work in order to safeguard against accidents from the acid. Of course, the well should be bailed as dry as possible before introduction of the acid. In view of the interesting possibilities connected with the experiment it might be desirable to have someone present from the Research Department.

Additional information might also be obtained concerning the possibility of preventing the formation of the scale. In this connection your attention is directed to our Memorandum of May 24th, on this subject. In addition to the information requested at that time we would also like the following information:

1. How are the wells in this field pumped? (Information as complete as possible.)

2. If pumped by vacuum lift what is the vacuum maintained?
3. Is there any information showing whether there is a positive or negative pressure on the sand when the vacuum is taken off?
4. Are there many abandoned wells in this field and if so how are they closed off?
5. Is there any evidence of a negative pressure (vacuum) on abandoned wells which might allow air leakage into the producing sand?

July 20, 1928.

Pittsburgh, July 20, 1928.

Mr. Henry McGraw,
Tulsa, Oklahoma.

Dear Sir: You have received or will receive very shortly a copy of a report made by Dr. Blaine B. Wescott on scale formation in wells in the Glenpool and means for its removal. I discussed this at length with Dr. Foote yesterday and he repeats the assurance that there is no possible way in which this treatment can injure a well, either the steel or the sand.

Also, Dr. Foote is strongly of the opinion that this treatment will increase the production because he believes it will remove the gyp which must surely in many cases be deposited on the face of the sand. Therefore, entirely aside from the question of removing scale from tubing it would seem very probable that this method is a very desirable one for treating the producing sand. The cost is comparatively negligible.

For all these reasons I therefore endorse the recommendation made on page 18 of Dr. Wescott's report that the removal of the scale by use of hydrochloric acid and 4% Rodine No. 2 or other inhibitor of equal effectiveness be tried in one well in the Glenpool.

It is not vitally essential that you try the experiment in the Glenpool if you should conclude that there is some other well which for some reason would be a better one to use in making the test.

I know you feel as I do that this is a very interesting subject and I hope you will proceed as promptly as possible to make the test and that you will arrange to have a very accurate technical detailed report kept as to exactly how the test was made, a precise description of the material used, the subsequent experiments that are made to determine the effect, and all other details that may be necessary to make it possible to draw a correct conclusion from the experiment.

These reports of course should be sent to Dr. Foote and I would like to have copies sent to my office in duplicate. Also I suggest that the reports be sent out as you progress rather than to await the final result so that the Research Department, particularly, may keep up with the experiment as it progresses and perhaps make suggestions of value as the work proceeds.

Yours very truly,

H F. H. Leovy.

Production Department, Engineering Report.

Tulsa, Okla., August 24, 1928.

Subject Treatment of Gyp at Glenpool

Assignment No. 38. Written by R. L. Wright

Consulting Eng. Production Eng. R. L. Wright

The recent report on Gyp, written by Mr. Wescott, of the Gulf Oil Research Laboratories, transmitted to Mr. McGraw in the letter of June 1, 1928, is very interesting and seems to be logical.

I have discussed this report with Mr. Case and Mr. Hays. They both expressed an opinion that we should go ahead and try it out. While the report inferred that the prime cause for using this would be to wash the face of the sand for the purpose of increasing the production, Mr. Case and Mr. Hays both were of the opinion that from an operating point of view they would like to lubricate it into the well often enough to prevent the deposition of gyp. In other words, they would also expect an increase in production from more continuous operation.

Mr. Hays has selected William Berryhill No. 8 as the well in which he would like to make the experiment. The log of this well is as follows:

Completed April 28, 1907
6⅝ casing set 1425
Top of first sand 1428
Top of second sand 1493

We do not have the complete record of where the break is.

Well was shot 9-1-08 with 110 quarts during a clean out from 8-24-08 to 9-8-08.

From 6-1-19 to 6-21-19 well was drilled deeper to 1515 still in sand. It was shot with 40 quarts from 1482 to 1515.

From 10-6-22 to 11-16-22 well was cleaned out and shot with 20 quarts from 1491 to 1511. Production was increased from 1 to 5 barrels per day.

The present production of this well as shown by our July, 1928, individual well report is 5 barrels of oil and 13 water. The well has 27" of vacuum. It has a 2" Penrod Thompson barrel. The perforation is 19 feet off bottom. Well is pumped 6 hours per day with a motion of 12" stroke, running 14 strokes per minute.

Regarding our trouble with gyp. It gives us trouble both on the inside and the outside of the tubing. In both cases the trouble is near the bottom of the hole.

Analyzing the problem of using the suggested treatment: First we must consider there is an underground vacuum. This is strong enough so that water cannot be kept on bottom for cleaning out. Thus, we could not pull the tubing and dump in a large quantity of acid as it would go back into the sand. Where the tubing is pulled and when the well is put back on, it is sometimes 48 hours before the well starts producing. It seems the logical thing to do is to lubricate the acid into the well while it is still pumping and the vacuum is maintained. Regarding the amount of acid to use: It will take 2 pounds of commercial hydrochloric acid to dissolve one pound of calcium carbonate or scale. The scale weighs 181 pounds per cu. ft.

The amount of scale present is not known. Estimating that the scale is 1/16" thick over 400 feet of annular space between the casing and the tubing, the scale being on each side of the tubing and the inside of the casing, and considering the face of the sand coated with the same thickness for 90 ft. of sand exposed over an average diameter of 5 ft. since the well has been shot heavily. The total of this gives 2640 sq. ft. of gyped surface. This gives approximately 14 cu. ft. of scale which should weigh 2530 pounds. The above thickness of scale was estimated after a discussion with all the farm bosses of the Glenn Pool District. On this basis, our requirements for acid then will be 5060 pounds. This amount of acid will cost approximately, at $2.10 per 100 pounds, $106.25.

The amount of inhibitor required for a 4% solution by volume would be 20½ gallons. At a cost of $3.50 per gallon the inhibitor would cost $71.75.

In carrying out this experiment in the field, there are other factors to consider. We would not want to take a chance of pumping this acid from the well to our stock tanks, as the inhibitor might deteriorate and the acid attack our tanks. We realize that the acid would be almost destroyed after it had attacked the scale, yet as a precaution, I believe we should set a small tank at the well and pump into it. Most of the water and weak acid would be drawn off and the remainder neutralized with ammonia lye or some other base before it is pumped into the stock tanks.

Another precaution we should take is, while the inhibitor practically protects steel, yet there is a slight attack. With a ball and seat just a slight wear soon causes it to cut out rapidly. For this reason, we should have a barrel that the standing valve can be pulled with the rods. A round trip could be made in a few hours with new balls and seats, and well put back on production.

For lubricating the acid into the well, we should arrange an air-tight lubricator, so that it will not interfere with the vacuum being pulled. This could be arranged with a barrel and a gauge glass that would make the amount of

fluid visible that was being lubricated. This should discharge into a connection at the casing head.

We should add the acid at a slow enough rate such that the total volume being produced from the well would not be more than the pump will handle.

I would recommend we proceed with this experiment by arranging with Mr. Hays to have a small tank set at the well, and install a new O'Bannon barrel. Have a suitable lubricator made at our shop, requisition 25 gallons of inhibitor and 5100 pounds of acid. Our own laboratory could furnish the necessary chemical apparatus for testing the fluid pumped from the well. The experiment should be watched very closely and a full report made on the results.

The amount of inhibitor recommended would be enough for us to make some tests on Waukesha and Superior engine blocks that are scaled up. This test could be made at our machine shop.

RLW:HG

Production Department, Engineering Report.

Tulsa, Okla., September 14, 1928.

Subject: Treatment of Gyp at Glenpool.

Assignment No. 38 Written by Fred W. Karl.

Consulting Eng., Hollis P. Porter.

Production Eng., R. L. Wright.

In Dr. Wescott's report on the above subject, the method of expressing the results of the water analyses is rather unfortunate as this method of hypothetical combinations is frequently misleading. For example, the combinations as given would indicate that no magnesium bicarbonate existed in the solution and yet a portion of the scale in each case was formed by the decomposition of magnesium bicarbonate as shown by the scale analyses. The point as to the presence of small quantities of strontium salts in the scale being due to occlusion can be more easily explained by calculation of the concentration of strontium sulfate. This shows that within the error of the analysis the concentration of strontium sulfate, not shown in the hypo-

thetical combinations, is equal to the solubility product and that the strontium in the scale was precipitated as sulfate.

Under the conditions of the well operation at Glenn Pool, the use of sodium bicarbonate to prevent the scale formation would not be feasible. This was demonstrated in the laboratory by adding the bicarbonate to a sample of water when considerable precipitate formed. This would be greatly increased in the well due to the action of the reduced pressure.

It is evident, as stated in the conclusions of Dr. Wescott's report that the release of dissolved carbon dioxide in the fluid as it enters the well cavity is responsible for the deposition of the scale, hence addition of more bicarbonate would be of little value in preventing scale accumulation. The third conclusion, that acid is the only commercially available solvent is not strictly true as will be discussed later. Under the sixth heading, it is stated that treatment of the fluid in the well is not economical. Actually this is not difficult, as several successful installations are in service for treating well fluid to prevent the formation of emulsions. Such an operation is particularly simple where the well is operated under vacuum. Again, the wells which are giving the greatest amount of trouble are producing less than ten barrels of water per day so that it should not be difficult to treat them.

Checking the calculations in Mr. Wright's report, it will require 2.3 pounds of 20° Be. acid to dissolve one pound of calcium carbonate and somewhat more if there is much of the magnesium carbonate associated with the calcium. Then, 2530 pounds of scale will require 5800 pounds of acid and 24 gallons of Rodine. This would increase the total cost of chemicals to $209.50.

As is suggested, there may be some trouble with the valve mechanism as it will be necessary to carry free acid past the valve in order to dissolve the scale in the tubing. If the process of lubrication is extended over a long period this may cause some corrosion of the ball and seat.

Conversation with the field foremen who are having

trouble from "gyp" formation developed that the real trouble is with the scale which forms inside the tubing. Many wells which show a full sixteenth of an inch of scale on the inside will have little or none outside. Although it is possible that much of the outside scale is knocked off in pulling, yet it would seem that some of it should remain to show that it had been there. When the scale forms inside the tubing string the working barrels scale heavily just above and below the travel of the cups. Then if the rod-line expands or contracts considerably so that the cups are forced into the scaled portion, they will bind and it is frequently necessary to pull the tubing to get the cups out of the barrel. Frequently the scale from the rods and tubing will fall into the barrel and being carried up and down by the cups, score the sides or jam the valves open and the pumping ceases. The following table shows the number of times certain wells have been off production because of "gyp" trouble during the first six months of the present year:

Lease	Well No.	Month or Months in Trouble	Production Oil	Production Water	Hours Pumped Per Day
J. Anderson	1	March, April	15	10	18
	3	February	7	5	12
	9	March, May	9	3	9
	23	February	11	5	10
A. Y. Barnes	2	March, April, June	10	6	18
	3	May	3	2	6
	7	May	3	½	4
	9	Jan., Feb.,Mch., May	10	1	12
	16	April, June	10	6	15
E. Berryhill	3	February	9	2	10
	4	January	5	4	7
	5	June	10	8	18
	44	February	8	2	8
Wm. Berryhill	8	March	5	3	10
	9	January, April	5	10	24
	15	April	5	8	12

Plaintiff's Exhibit 153

Lease	Well No.	Month or Months in Trouble	Production Oil	Production Water	Hours Pumped Per Day
	26	February, June	10	10	24
	32	April	6	10	18
Clanton	6	May	4	4	7
	16	February, April	6	4	12
	17	Jan., Mar., Apr., May	4	4	12
M. W. Drew	2	February	5	2	12
	13	March, April	6	4	12
	15	March, May	8	4	18
	20	Jan., Feb., May	9	4	12
	21	Feb., April	9	6	18
	22	March	6	3	12
L. P. Escoe	8	February, March	6	8	24
T. Gilcrease	21	January, May	2	12	22
	22	June	4	5	13
R. L. Hood	6	January	1	4	4
	16	June	½	6	12
	17	January, February	2	6	12
	18	June	½	6	20
L. Pitman	10	April	3	3	12
	13	April	4	4	12
	16	March	3	5	12
	17	May	3	3	10
	18	May	2	3	8
	21	February	3	10	24
	28	March, April	3	5	7
R. Pitman	4	June	4	6	20
	8	January, April	3	4	10
	32	June	3	3	8
J. P. Rhodes	11	June	3	6	4
	15	February	½	15	10
B. Sells	9	March	7	0	24
Jennie Spocogee	3	May	2	3	4
Jacob "	6	February	½	10	24
Sam Vowell	3	May	9	5	11
	10	March	8	4	11

Plaintiff's Exhibit 153

If the standing valve is working properly the scale could be removed from the tubing by running in about forty gallons of acid with the 1.6 gallons of Rodine needed for inhibition and allowing it to stand for a few hours, then pumping into a small tank with broken limestone in the bottom to remove any acid not used up in the reaction. Such a procedure would be less expensive than to treat all of the scale in the well, but would have no effect in increasing the production by removal of the scale on the face of the sand.

A simple experiment carried out by Mr. L. C. Case and the writer on a sample of the scale from the inside of the tubing indicated that the carbonates are fairly soluble in ammonium chloride (sal ammoniac) solution. This solution would have no effect on the well equipment and could be lubricated into the hole readily. It would require no added material to inhibit the corrosion reaction and as it is very soluble it would not cause any scale troubles. Experiments would be necessary to determine the concentration of the salt necessary and the amount of such solution needed to prevent further accumulation of scale in the well equipment.

Another method which might be used for preventing the formation of further scale would be to run into the well either a treated portion of the water produced by the well, such water to be freed from calcium and magnesium by the regular water treatment methods or simply a mixture of fresh water and water from the well, thereby increasing the amount of fluid in which the carbonates could be dissolved. The use of a water carrying some dissolved mineral matter would be necessary in order to prevent the formation of emulsion.

F. W. Karl.

FKW:HG

Plaintiff's Exhibit 153

September 27, 1928.

Dr. Paul D. Foote,
c/o Mellon Institute,
Pittsburgh, Pa.

Dear Sir: I duly received the comprehensive report prepared by Doctor Wescott on the formation of "gyp" in wells with his recommendation that we treat one or more wells with acid and rodine. Experiments along this line have been delayed by the activity in Little River and elsewhere which demanded all the time of our available engineers.

The treatment of wells in Glenpool with this acid will be difficult because the pool has long been operated under high vacuum and the sand is so porous that as long as a well is open, air enters the well and passes through to adjacent wells on which vacuum is being maintained. Therefore, it will be impossible to open a well and pour in the acid. The vacuum would rapidly carry the acid back into the sand. Neither would it be feasible to put the acid in a well and maintain vacuum for the fluid would exert a pressure of 80 to 120 pounds per square inch over the face of the sand and the vacuum from surrounding wells would rapidly carry the water into the sand. These are not merely theoretical conditions. Experience in cleaning out work shows that it is very difficult to maintain water at the bottom of the hole sufficient to facilitate drilling and bailing operations.

Therefore, it appears that the only method by which the acid can be used in the hole is by permitting it to trickle down the casing and be immediately pumped out through the tubing. In this way, the casing, tubing and sand face can all be washed with acid without removing the vacuum. There would be little tendency for the acid to be drawn back into the sand since there would be no pressure against the sand face.

Accordingly, a lubricator will be designed through which the acid can be passed into the space between the tubing and casing while pumping is continuously carried on.

The acid with 4% of rodine No. 2 will be fed into the well and steadily pumped out. A chemist will be on hand to check the material and if the acid is not spent, it will be returned to the hole again. In this way, we shall accomplish a thorough washing of the face of the sand and should determine whether the sand is sealed off with carbonates as we all believe is the case. You will be advised of the results of the experiment when it is completed.

In part, this letter answers the questions raised in Doctor Wescott's memorandum which accompanied the report. Specifically, however, the information is as follows:

1. The wells in this field are pumped from two to eight hours per day. The stroke varies from 12 to 30 inches and the rate of pumping is about 14 strokes per minute.

2. Vacuum is maintained on all wells and ranges from 25 to 27 inches. This vacuum has been maintained for approximately ten years.

3. There is a definite negative pressure on the sand and air enters any well which is open and passes readily to adjacent wells.

4. Abandoned wells in this field have been plugged by filling with mud and capping the hole with cement. Analyses of gas from adjacent wells indicate that no appreciable amount of air enters the sand through the abandoned wells.

5. Abandoned wells are so plugged off that it is believed no air can enter the sand, although water might reach it.

It has been stated that the use of acid will in nowise damage the wells in Glenpool. On this matter I am not convinced. If the sand is cemented with calcium carbonate, it seems quite probable that the acid will loosen considerable sand and may result in much sand coming into the well. It is possible that we may have to move in tools and clean out if the acid-washing operation is carried too far. This is, of course, an additional argument in favor of using the continuous system rather than letting the acid stand in the hole for some time. Samples of Glenpool sand are not available to check this possibility.

It seems probable that the hole at the bottom of the well is much larger in Glenpool than many areas where the rocks are more solid. Field men report that after a shot it is not at all uncommon to remove scores of cubic feet of sand from the hole. In two cases, at least, we have lost strings of tools in the hole which could not be found by any fishing tool. Apparently they slipped off to one side and were entirely out of the reach of the fishing tools which were used to search for them. In another case, a bit was found lying crosswise in the hole and, of course, was not recovered. All of this evidence indicates that shooting and the repeated cleaning out of these wells may have developed cavities with cross-sections exceeding several square feet.

Yours very truly,

RSK:MG

November 20, 1928.

Dr. Paul D. Foote,
Mellon Institute,
Pittsburgh, Pa.

Dear Sir: I enclose a belated comment by Mr. Karl on Dr. Wescott's report on the Glenpool gyp.

The first experiment with the acid has been run at Glenpool with unsatisfactory results. I indicated in my previous letter that the acid might release much sand which would seriously interfere with pumping. Experience shows this is the case. The acid apparently destroyed much gyp but the pump was choked with sand and it has been necessary to pull the pump several times in order to get the well to pumping normally. The experiment has not yet been carried far enough so that we can determine whether the production of the well will actually be increased by this treatment. Further experiments will be made and you will be advised from time to time of the results.

I should note that Mr. Karl is not now so confident of the value of ammonium chloride as he was when he wrote this note. Further laboratory tests are being made but it appears that a very concentrated solution is necessary to

remove any large quantity of gyp. Such a concentration is not practical under ordinary field conditions.

Yours very truly,

RSK:GS

Tulsa, Oklahoma, February 5, 1929.

Dr. Paul D. Foote,
Mellon Institute,
Pittsburgh, Pa.

Dear Sir: The following preliminary report is quoted for your information, regarding the treatment of wells in Glenn Pool with hydrochloric acid:

(Here follows a copy of DX-152.)

The well is not equipped to permit the taking of an individual gauge of its production. However, the well pumped seven hours daily before treatment and since that time it has pumped at approximately the same rate. The treatment has apparently not benefited the well production. Whether it has reduced the amount of rod and pump trouble must be determined by further observation.

A peculiar feature of the operation is that no appreciable amount of water was recovered from the well. A small amount must have been present as shown by the acid reaction obtained by washing the oil. The loss of the water illustrates the ease with which vacuum pulled the fluid back into the sand when the well was opened.

Shortly I expect to treat the tubing in several additional wells, and further report on this subject will be sent you later.

Yours very truly,

RSK:AS

May 10, 1929.

Mr. M. O. Rife, General Superintendent,
Gulf Refining Company of Louisiana,
Shreveport, Louisiana.

Dear Sir: In the Glenpool field which you visited late Thursday afternoon, as I advised, we experience consider-

able operating difficulties due to a scale formation, generally referred to as "gyp."

The analysis of this material, according to a report of Mr. Stanley Gill under date of May 5, 1928, is as follows:

Insoluble materials	.30%
Iron and aluminum oxide	4.85%
Calcium carbonate	78.00%
Chloride	Trace
Strontium carbonate	10.80%
Organic and moisture	Balance

This scale very often causes rods and tubing jobs and when the material is pulled out of hole it is found that barrel and valve are so firmly set with it that it cannot be removed, and the equipment is junked. In some instances the formation has been on the outside of the tubing to the extent that it was necessary to move in tools and fish tubing out of hole.

When this matter was placed before the Research Department a treatment was recommended and a well on the William Berryhill farm was selected. This well had a record of tubing jobs in March, July, September, and November, of 1928, on account of gyp and during one month of this period tubing had to be removed from the hole four times. Since December 1, up to this date, this particular well has not been pulled on account of gyp formation. The treatment recommended was hydrochloric acid mixed with rodine. It apparently has worked out satisfactorily but its cost is prohibitive.

I was therefore interested in your statement that you have a like condition on one of your properties and that this gyp formation is being removed successfully with a chemical furnished by the William S. Barnacle Company of St. Louis, and no doubt the materials or chemicals that they furnish you can be used at a much less cost than the treatment used in our experiment. When you find it convenient, I will be pleased if you will advise the name or number of the chemical that the Tret-O-Lite people are furnishing you for this purpose.

Yours very truly,

CPD:SG

Plaintiff's Exhibit 153

Pittsburgh, July 8, 1929.

Mr. Henry McGraw,
Tulsa, Oklahoma.

Dear Sir: Some time ago we had considerable correspondence with your office about gyped tubing. The last report by the Gypsy Oil Company on the removal of gyp by hydrochloric acid was made on February 5th. Prior to that time we had reports from you of considerable trouble with gyped tubing. It would be interesting to know whether the remedy suggested by our Research Department has been effective or whether you are still having trouble.

Yours very truly,
F. H. Leovy.

Tulsa, Okla., August 5, 1929.

Subject: Treatment of Gypsum at W. Berryhill No. 8.
Assignment No. A-17-6, written by R. L. Wright.
Consulting Eng. D. R. Trax. Production Eng. R. L. Wright.

The report of February 1, 1929, on the treatment of gypsum at W. Berryhill No. 8 stated that the well had not been pulled for gyped tubing since the treatment in November, 1928. The present status of the test is that the well has not been pulled for gyped tubing up to August 1st, 1929. The production of the well, however, has not increased.

This test has gone far enough to indicate that some pulling jobs for gyped tubing can be eliminated. However, it is doubtful if production can be increased. A summary of the results show this well was pulled three times in eight months previously to the treatment, and has not been pulled in eight months after the treatment.

The cost of the chemicals used in this particular treatment (hydrochloric acid with an inhibitor) was approximately $35.00.

We now have a chemical made by the W. S. Barnacle Company for gypsum treatment. The amount of the chemical recommended for a treatment is 100 lbs. This will

make the chemical cost approximately $10.00. We intend to make this test in the very near future. If it develops that the chemical made by the Barnacle Company will give as satisfactory results as using acid with an inhibitor, due to its low cost we would recommend its use.
RLW/b

Tulsa, Oklahoma, August 9, 1929.

Mr. F. A. Leovy,
Pittsburgh, Pa.

Dear Sir: Your letter of July 8th, without file number, requests a supplementary report on the treatment of a well in Glenpool with acid in order to remove the so-called "gyp." Attached is a report giving the limited information we have on this subject.

From this it appears that at a cost of $35.00 we have saved at least three pulling jobs on the well. The treatment has therefore been entirely successful and has resulted in a saving of not less than $20.00 on this well.

No improvement in oil production has been shown.

Due to the resignation of our chemist, we have not followed up this experiment as we wish to. Shortly I hope to treat other wells with acid and to extend these experiments in an effort to determine whether oil production cannot be improved as well as benefiting our production.

Yours very truly,

RSK:GS N

Production Department, Engineering Report.

Tulsa, Okla., August 30, 1929.

Subject: Test of Gyp Solvent X-1, manufactured by the Tret-O-Lite Company for Treating Gyp in Wm. Berryhill #26, on August 5, 1929.

Assignment No. 17-6, written by R. L. Wright.
Consulting Eng., D. L. Trax.
Production Eng., R. L. Wright.

The history of the well for the year previous to this test shows that the well was pulled three times for gyped

tubing, the last time being May, 1929. In August, 1929, the well was to be pulled again for gyp, so it was decided to test the gyp solvent in this well. The test was conducted on August 5, 1929, as follows:

The condition of the well was that it was impossible to pull the rods as the gyp in the upper part of the common barrel would not allow the plunger and cups to be pulled through it. Thus, it was a stripping job of pulling the tubing. An attempt was made to pour some of the treating compound down the tubing to attack the gyp in the upper part of the barrel, but the tubing was already full of salt water and the gyp solvent would not go down. Had this been successful, the tubing would not have been pulled unless the standing valve needed replacing.

The tubing itself was stuck to the casing by the formation of gyp. Fresh water was poured in the annular space between the tubing and the casing in an attempt to dissolve the gyp so that the tubing could be pulled. The well stood five hours to allow this to take place, but was not successful, as the tubing was still stuck. Ten pounds of gyp solvent dissolved in one barrel of fresh water was then poured down the annular space and the well allowed to stand for two hours. The tubing then pulled easily. A new common working barrel was then run back into the well.

After the tubing was rerun, 90 pounds of solvent dissolved in three barrels of fresh water were lubricated into the well. A small amount of this, however, was put in the tubing. The well was then put to pumping and run two hours, to get the chemical which was put in the annular space up into the tubing.

When the tubing had pumped up full, the well was shut down and allowed to set for 18 hours. It was then started up and the solvent was re-circulated for 12 hours. During the first part of this time a chemical test showed that some of the solvent was being re-circulated. However, after 12 hours, chemical test showed that the solvent had been destroyed by its action on the gyp. The manner in which the solvent was re-circulated was that it was pumped into a

barrel at the well head and allowed to drain from the barrel into the casinghead. In this barrel we found several small pieces of gyp which had been loosed from the tubing.

On August 8, 1929, or three days later, it was necessary to pull the well for cups. We feel that this cup job was probably caused by some small pieces of gyp getting down on the cups, cutting them out. On August 13th, the well was pulled, due to a leaking tubing point. An inspection of the tubing when it was out of the hole on this job showed that there was a considerable gyp left in the tubing.

The cost of this chemical is 11c per pound at St. Louis. A total of 100 pounds were used in this test. Its composition, according to Mr. Case of our laboratory who made the analysis, is impure ferric chloride.

The results obtained from this treatment, we feel, shows a small amount of benefit, but we do not feel that the treatment was anywhere near as successful as the treatment of William Berryhill No. 8, approximately nine months ago, with hydrochloric acid, using an inhibitor.

This checks the opinion expressed in the report of the Research Department under date of July 12, 1929, on Solvents for Scale Deposits in Wells.

In view of the above results, we recommend that we do not use any more of this particular gyp solvent.

RLW:HKG

Mr. W. B. Wilson, Building. Tulsa, Oklahoma, July 21, 1931.

Subject: Explanation of results of acid treatment in Gypsy No. 3 J. Anderson.

Dear Sir: Results of this test have been observed since July 1, when the test was begun. Some of these results were stated in a letter of July 16. Since that time, it has been found that the addition of larger amounts of acid to the well definitely increases the bicarbonate in the water being produced with the oil. This rise in HCO_3 content, together with the increase in the calcium ratio of the water, show that the acid is encountering $CaCO_3$ on the casing in going down.

If acid were added directly to the water in the bottom of the well the reaction would be:

$$Ca(HCO3)2, + 2HCl = CaCl2 + 2H2O + 2CO2$$

Also, if sufficient acid is added to calcium carbonate to bring about a complete reaction, we have:

$$CaCO3 + 2HCl = CaCl2 + H2O + CO2$$

However, if this reaction takes place in a phase of excess carbonate, the reaction is complete:

$$2CaCO3 + 2HCl = Ca(HCO3)2 + CaCl2$$

An example of the last reaction was performed in the laboratory. A solution of acid (1 to 20) was allowed to gravity through a 2 ft. column of crushed limestone. The reaction all took place in the first 2 inches of the column, that is, the acid was completely neutralized in that distance. The solution then percolated through the rest of the crushed stone without having any effect. This percolate was titrated and found to contain 298 p.p.m. of bicarbonate. This is precisely what is happening in the well.

Conclusions

When this treatment was suggested, no trouble was anticipated in getting the acid to the bottom of the well. It has been shown that the acid is being neutralized by scale on the casing, so that, after reaching the bottom, the solution increases the scale forming compounds in the water. This condition is the reverse of the desired result and the reverse of what would happen if the acid were added directly to the water.

Since the scale forming (calcium bicarbonate) material is increased in the water being pumped, it is entirely possible that more scale is forming on the valves and rods than before. However, there is also the possibility that the water contains sufficient carbon dioxide from the reaction to hold the scale in solution. In either case, it seems logical to conclude that present results do not merit a continuance of the test unless it is thought that larger quantities of acid will clean off the casing and allow the acid to get down.

Very truly yours,

L. C. Case.

c.c. Mr. Sanderson
Mr. Power
Mr. Rushmore

Plaintiff's Exhibit 153

Pittsburgh, Pa., July 22, 1931.

Mr. K. Winship,
Tulsa, Okla.

Subject: Chemical Treatment of Wells. FA-20.

Dear Sir: During recent visits to Tulsa both Mr. Loomis and Dr. Wescott have discussed the possibility of preventing the deposition of gyp in wells of Glenpool and other similar fields by two possible methods:

First: The lubrication of acid Rodine mixtures continuously into the wells, and

Second: The lubrication of a protective colloid to prevent the formation of a hard scale.

There seems little doubt that the scale is formed as the result of the release of carbon dioxide from the water when it enters the hole. In order to determine the feasibility of the second method mentioned above, we would like to request the shipment of two 5-gallon carboys of Glenpool water to the laboratory. No experimentation is necessary in the laboratory for the use of the first method mentioned above since the amount of acid required can be readily calculated from the analysis and the amount of water produced, and it can then be lubricated into the well in the same manner as is now used for the Tret-o-lite paraffin remover. However, it will be necessary to conduct laboratory tests to determine the value of protective colloids in keeping any calcium carbonate released in the form of a sludge which will be flushed from the well with the fluid produced. The water requested will be used for this latter purpose.

Very truly yours,

BBW:NCK (Signed) Paul D. Foote.

Production Department Memorandum
Monthly Summary & Progress Report.

October 1, 1931.

Water Treatment:

The Gypsy Oil Company has three International Water Softening Plants. However, only two are in operation at present, those at Jenks and Little River. The treat-

ment at the plants seems to be effective, the water seldom showing more than 3 to 5 grains total hardness.

The last shipment of lime to the Jenks plant was found to be of inferior quality from the standpoint of water treatment. Satisfactory results required the use of approximately 75% overcharge of lime. This item will be watched to see that lime of the correct analysis is purchased in the future.

Salt and Gyp Treatment:

A test covering a period of 18 days was conducted in Jacob Anderson well #3 to determine the effect of a daily charge of hydrochloric acid in the hole on the formation of "gyp" or calcium carbonate. Results of tests on the water produced led to the conclusion that the formation of scale was being accelerated instead of inhibited. Further work will be done along this line.

Production Department, Engineering Report.

Tulsa, Okla., December 4, 1931.

Subject: Prevention of Scale Deposition in J. Anderson Well No. 3.

Assignment No. 17-B, written by W. L. Rushmore.

Consulting Eng., D. L. Trax.

Production Eng., H. H. Power.

Conclusions.

The test at J. Anderson Well No. 3 was started on July 1st, and discontinued on July 20th. The first intentions were to make at least a thirty-day trial but in light of the results obtained and the possibility that more scale was being formed than would be naturally, it was thought advisable to discontinue the trial.

The above conclusions were arrived at after the water began to show a very high bicarbonate content which was the exact opposite to what had been expected.

It has been decided to try mechanical means of combatting the carbonate formation.

* * * * *

Plaintiff's Exhibit 153

Production Department, Engineering Report.

Tulsa, Okla., April 12, 1932.

Subject: Gyp Scraper in T. Gilcrease No. 21.
Assignment No. 17-6, written by W. L. Rushmore.
Consulting Eng., D. L. Trax.
Production Eng., H. H. Power.

Conclusions.

It is concluded from the results of this trial that the use of a scraper plunger in gyp wells as a mechanical means to prevent deposition of scale will materially reduce pump trouble.

It is recommended that further trials be made of this type plunger in the Glenpool District.

* * * * *

Considerable trouble has been experienced with the formation of "gyp" in the common barrel with which Thomas Gilcrease well No. 21 is produced. The "gyp" or calcium carbonate was deposited in the working valve, in the barrel above and below the cup travel, in the lower part of the tubing and on the lower sucker-rods. Frequent cup jobs occurred, caused by the scale cracking off the rods and tubing and falling down in the pump. Too, the scale would gradually build up in the barrel, above the cup travel, until the top of the barrel was so restricted that it was not possible to pull the working valve. A tubing job would result. Treatment with hydrochloric acid, down the hole, in a similar well was not successful. It was decided that mechanical means would offer a more effective method of combating this trouble.

Trials have been made in the Cleveland District of a scraper tube used in the place of the common valve stem. The tube was of such a length that it would work out of the top of a common barrel at all times, and would fit the barrel close enough to scrape any deposition off as it was formed.

A similar plunger was made up for use in Thomas Gilcrease Well No. 21 in the Glenpool. A worn out O'Bannon tube with top bushing and crown formed the body of the plunger. The connection between the lower end of the

tube and the working valve was made of an O'Bannon part L. B.-13 which had been turned down to allow a free movement inside a 1-25/32" A. P. I. common barrel, and which had male threads cut on the upper end so as to screw into the tube. The common valve body carrying 1-25/32" cups was screwed into this bushing. The connecting bushing also carries the traveling valve ball and seat. The attached sketch shows the position and appearance of the plunger in a common barrel.

The scraper, as described above, was run in Thomas Gilcrease Well No. 21 on October 14, 1931. The trouble record of this well from January 12, 1931, to March 31, 1932, and the resulting costs are shown in the attached table.

A marked decrease in trouble will be noted in the table. The well was serviced twelve times in 271 days, or on an average of once in 22 days. The first pulling job occurred 158 days after the scraper was installed. However, it seems to be hanging up on October 17, 1931, three days after its installation. The well was bumped and put to pumping with no further trouble until it was pulled for cups on March 22, 1932.

The table shows a cost of $0.404 per day before installation of the scraper and $0.23 per day after. The decrease in the days servicing costs amounts to 43 per cent. The charge of the tubing job on October 14, 1931, when the scraper was installed, covering labor and material amounting to $26.89, was included in the cost of operating the well after the scraper was installed. A more decided decrease should be noted after a longer operating period.

RLR:AHB.

Plaintiff's Exhibit 153

Production Department, Engineering Report.

Tulsa, Okla., April 14, 1932.

Subject: 1" B. M. W. Pump—Jacob Anderson No. 3.
Assignment No. 17-6, written by
Consulting Eng.,
Production Eng.,

Conclusions.

The results obtained from the 156-day trial of the 1" B. M. W. pump in Jacob Anderson Well No. 3, do not warrant its further continuation in this well.

Recommendations.

It is recommended that the 1" B. M. W. pump be removed from this well and that a scraper plunger such as is now in use in Thomas Gilcrease No. 21 be installed. The small pump should be transferred to a well not troubled with gyp.

• • • • •

Several wells in the Glenpool produce a water from which "Gyp" or calcium carbonate, is deposited on the producing equipment. Sand is also present in these same wells. Under these producing conditions the maintenance cost of a working barrel is excessive.

Jacob Anderson No. 3 shows both sand and gyp and is a consistent trouble maker. Attempts were made in July, 1931, to control the gyp deposition by means of hydrochloric acid introduced in the hole. The results of these trials were not favorable. Attention was then turned toward the possibility of inhibiting the scaling action by physical or mechanical means. It was thought that continuous pumping at a slow rate might produce a smoother flow of fluid through the pump thereby offering less opportunity for the escape of CO2 from the water. The precipitation of the scale is caused by the escape of the CO2 from the bicarbonate, which leaves the insoluble carbonate.

The power on the Anderson lease is operated at 8 strokes per minute which is at the lower limit of its speed variation. This particular well produces 8 barrels of oil and 3 of water on an 8-21" cycle. The pumping time when

using a common barrel was 12 hours daily. To obtain slower pumping necessitated the use of a small capacity pump.

A 1" B. M. W. pump was installed on October 27, 1931, and operated on the same cycle as the common barrel but was operated straight time. The small pump was pulled the first time on December 10, 1931, for cups. This was a 44-day run and incidentally the longest run obtained to date.

The attached table includes the trouble record and material and labor cost for pump service only from April 1, 1931, to April 2, 1932. The table shows a slight increase in operating expense for the small pump as against the 2" common barrel used previously. However, over an equal period of time the cost might possibly show a decrease. It can hardly be expected, judging from the data now at hand, that a large difference in service charge will ensue from its continued use.

It was observed that the small pump would become encrusted with scale in the same manner as the common barrel. However, the small pump would cause trouble sooner than the larger one because the smaller fluid passages would be reduced with resulting flow restrictions. The use of the small pump is advantageous in that it can be installed on the rods and not cause a tubing job.

It cannot be said that operating conditions in this well have been improved, even though the pumping time has been lengthened from 12 to 24 hours. The pump efficiency was increased slightly, from 50% to 58%.

It is recommended that the 1" B. M. W. pump be removed from this well and that a scraper plunger such as is now in use in Thomas Gilcrease No. 21, be installed. This plunger was described in a report dated April 12, 1932.

WLR/AHB.

Plaintiff's Exhibit 153

Pittsburgh, Pa., May 14, 1932.

Mr. K. Winship,
Tulsa, Okla.

Subject: Prevention of Scale Deposition. FA-21-1.

Dear Sir: In a letter dated January 12th you discuss scale deposition troubles in Glenpool wells and point out that it would be too costly to treat the fluid in the bottom of the hole with acid, for scale extends from 200 to 400 feet up from the bottom of the casing and all of this scale would have to be removed before the acid would reach the bottom-hole-fluid. You suggest that, if possible, a treater should be developed that would not be destroyed by reaction with the scale before reaching the bottom.

We have in mind that a cheap colloid, such as tannin, might be added down the casing. This colloid is recommended as a boiler feed-water treater and acts in some way by absorption to cause calcium carbonate to form a flocculent precipitate rather than a fine crystalline powder, thus destroying the tendency to scale, with the result that the flocculent material is easily eliminated when the boiler is blown down. As an example, our analysis of Dearborn Boiler Scale Remover shows that tannin is the main constituent.

It appears by analogy that the same treatment might be used to prevent scale deposition in the wells. An alkaline solution of tannin should cause the calcium carbonate to form as a gelatinous precipitate, which would float out with the liquid. The scale already in the casing would not destroy the chemical on its way down, of course, as is the case with hydrochloric acid. A few experiments that we have tried in glass and steel beakers showed that the scale-forming properties of calcium carbonate are destroyed by small amounts of tannic acid, sodium tannate, waste alkaline liquor from the Lake Charles (La.) Products Company and Stabilite. These latter two products contain tannins.

I believe that we can conclude that the proposed method of treatment is somewhat promising if the cost is not too great. Wescott and Loomis are planning a series

of tests with a constant amount of calcium carbonate in each case to find the smallest concentration of tannin necessary to prevent scale-forming tendencies and hence obtain some idea of the cost involved. The results of these tests will be reported to you as soon as possible.

Yours very truly,

AGL:P Paul D. Foote.

July 29, 1932.

Mr. K. Winship,
Tulsa, Okla.

Subject: Chemical Treatment of Wells—Gyp—Fa-20-1.

Dear Sir: In connection with our work on the prevention of gyp formation in oil well tubing we would like to obtain a piece of pipe covered with a good coating of gyp for the purpose of chemical and physical examination, and a sample of water from the same well for a similar purpose.

We have been considering gyp prevention and the problem is one which will be continued over a considerable period of time but one which, from the nature of the tests, requires practically no man hours. The apparatus is set up and run for a period of several days with little or no attention. We are in no hurry for this material but shall appreciate samples at your convenience.

Yours very truly,

PDF:G Paul D. Foote.

October 13, 1932.

Memorandum.

Today Mr. A. T. Wright, who stated he was associated with the Dow Chemical Company of Midland, Michigan, called on me. He stated that the Dow Chemical Company had been making some experiments with lime producers in Michigan fields by placing acid in wells. From 500 to 1000 gallons of acid are placed in a well through tubing, and pressure is then applied and the well allowed to stand 48 hours. A charge of $250.00 is made for the acid and labor required to place it in the hole.

Mr. Wright stated that in some cases remarkable results were obtained. He cited W. L. McClanahan's Shaffer #1 test in the East Mt. Pleasant pool. He stated that this well had an initial production of 125 barrels daily. It declined at a moderate rate for 25 days and then was treated with 1000 gallons of hydrochloric acid (20% concentrated), and it responded with a production of 725 barrels daily. At the end of 24 days the production had dropped to 336 barrels but in the meantime it had produced 8,600 barrels above what it was estimated it would have produced without the acid treatment. The test was then given another treatment of 1000 gallons of acid and the production thereby was raised to 850 barrels daily. Mr. Wright stated that the results in the case of this test were unusually successful but that the other wells had responded to the acid treatment with very substantial increases in production.

Mr. Wright also advised that the Dow Chemical Company, which is one of the largest, if not the largest chemical company in the United States, employing 3,500 men, became interested in treating wells with acid in an effort to use some of the acid by-products of their plant at Midland. This company has the process patented and has also a copyright on an inhibitor which is placed in the acid to prevent excessive corrosion of well equipment. Care must be used in using the acid with wells which are making water since in some cases the water content instead of the oil content has been increased. In general the process is expected to work best in situations where production is obtained from limestone of variable porosity and where the oil is accompanied by little water.

There is a possibility that this method of treating wells will have a practical applicability in Mid-Continent fields, and among the producing horizons the Hunton lime appears to be most suitable for trials. There is not much water in the Hunton lime and the variability of its porosity is illustrated by such wells as our L. Tiger No. 2 in Sec. 3-8-5. It will be recalled that No. 1 Tiger was a 3,500-barrel well and No. 2 only made about 75 barrels.

Mr. Wright is in Tulsa for the purpose of collecting samples of various lime producing horizons and interesting producers in trying out the acid treatment at some later date. He has associated himself in Tulsa with Mr. Frank Juerta who has offices in the Kennedy Building. As the treatment is relatively inexpensive there can be little doubt that it will be given a rather thorough trial in Oklahoma.

W. B. Wilson.

Dowell, Inc., January 18, 1933.
Midland, Michigan.

Gentlemen: On October 13, 1932, Mr. A. T. Wright called on me and represented himself as being associated with your Company. He did not exhibit a contract with you, but stated that he was authorized to solicit business for you in this territory. On this representation Mr. Wright received from us samples and cuttings from various representative lime wells in our territory, which he stated would be examined by you, in return for which we would be furnished the results of your analyses. The materials which our records show were turned over to Mr. Wright are listed below:

Oil Well Cuttings.

Gypsy Oil Company Nos. 1, 2, 4, 5, and 6 Cecil—Section 19-7N-4E, Oklahoma.
Gypsy Oil Company #1 Collins—Section 25-7N-4E.
Gypsy Oil Company #2 McGee—Section 23-7N-4E.
Darby Oil Company #1 Standridge—Section 15-7N-4E.

Oil Well Cores.

Texas Oil Company #1 Dinah—Section 23-5N-7E.
W. B. Pine #1 Tiger—Section 3-8N-5E.
Empire Oil #1 Alexander—Section 23-6N-3E.
Droppleman #1 Jones—Section 21-8N-3E.
Gypsy Oil Company #1 Masters—Section 25-6N-4E.
Gypsy Oil Company #1 Tiger—Section 3-8N-5E.

On November 27, 1932, Mr. Wright again called on me and stated that he was no longer representing you in this territory. He gave me written in longhand on Dowell, Inc.,

stationery, results of analyses of cuttings from Gypsy No. 1, 2 and 4 Cecil, listed above. He stated these were all the determinations that had been furnished him to date. We have received no others. Our purpose in writing you is to find out if, in fact, Mr. Wright ever submitted to you any other cores or cuttings which we furnished him, and if so, whether you can now give us results of your analyses of them. Some of these materials can be duplicated only with difficulty, if at all. Hence our desire to have a report on them. Recently your Mr. J. A. Cummin stated to us that he recalled analyses had been made of our materials, but he did not know to what extent. If your records show that these materials were received by you and have been examined, I assume it will be in accord with your policy to furnish us a copy of the analyses and we will greatly appreciate receiving them.

Yours very truly,

WBW:LAP

January 23, 1933.

In reply please refer to
J. W. Harris.

Gypsy Oil Company,
Tulsa, Oklahoma.

Attention Mr. W. B. Wilson.

Gentlemen: Your letter of January 20 regarding samples sent in by Mr. A. T. Wright has been received.

We have received all the samples listed by you from Mr. Wright and have analyzed them all. The results of the samples of the first four wells listed were sent directly to Mr. A. T. Wright at the time of analysis, but after hearing of Mr. Wright's misrepresenting himself as being our agent we did not send him the results of the analyses of the other samples. We did, however, send the results to our representative in Oklahoma at that time, Mr. John Staudt.

We have found that the results of the analyses prove to be very favorable for our type of treatment on all of these latter samples. We can tell by the percentage of solubility and percentage of Calcium Carbonate just about what suc-

cess we can have with our treatment on those certain wells. All of the samples had a high enough solubility and percentage of Calcium Carbonate for our treatment to be very successful.

This is all the information that we can give you by letter. We are very sorry that we cannot make public on paper the exact results which we obtained. Perhaps Mr. Staudt can make a trip to Tulsa in the near future and see you personally. In that case we are sure that he could give you a better idea of these analyses.

Yours very truly,

Dowell Incorporated,

JWH:JL J. W. Harris, Sales Department.

Dowell, Inc., January 30, 1933.
Midland, Michigan.

Attention Mr. J. W. Harris.

Dear Sirs: I wish to refer again to the subject-matter discussed in your letter to me of January 23 pertaining to well samples and cores furnished you by us thru A. T. Wright.

I am not sure that I have been able to make our position in this matter clear to you. As we see the situation, we were approached by a man who had certainly had some connection with your company. Upon his representation that he was authorized to solicit business for you he was furnished with materials from various wells, some of which cannot be replaced. It is customary in the oil business for companies to be furnished with copies of analyses of rock samples or water samples furnished by them to parties interested in making such analyses. If Mr. Wright had no connection with you it would have seemed only ordinarily prudent for you to check up with us, before making analyses of these materials, any obligations going with them. You state that you sent Mr. Wright results of analyses of four wells, but sent him no more at hearing that he was misrepresenting himself as your agent. It appears from this that it was your original intention to furnish him

Plaintiff's Exhibit 133

copies of all analyses. Such being the case, we cannot understand why we, who furnished the materials, should be held in a different status than was Mr. Wright originally.

In this connection I will say that it is not our intention to furnish Mr. Wright with these analyses or to make them available to the public. I will say further that the Gypsy Company is the Oklahoma and Kansas producing subsidiary of the Gulf Oil Company of Pennsylvania, one of the world's largest producers of crude oil. We believe that an investigation will reveal to you that our company is widely known for its honorable dealings and that it can be relied on to fulfill any agreements made by it.

I hope that a reconsideration of the facts will lead you to the conclusion that in accepting and using materials you necessarily assumed the obligations made in securing them and that you will decide to furnish us with the analyses in question. I agree on the part of the Gypsy Oil Company to see that they are kept confidential within our Company.

Yours very truly,

WBW:LAP

February 6, 1933.

Gypsy Oil Company,
Tulsa, Oklahoma.

In reply please refer to
J. W. Harris.

Attention: Mr. W. B. Wilson.

Gentlemen: This is in reference to the matter concerning the well samples and cores which you furnished us through Mr. A. T. Wright some time ago.

We agree with you that you are not in a different status than Mr. Wright was originally when we sent him the results of our analysis. It is not our intention to keep you from receiving these results but rather the fact that it is against our policy to send these results by letter. Mr. S. W. Putnam, the Manager of Dowell Incorporated, is at the present time making a trip into Kansas, Oklahoma, and Texas. In this trip he plans on calling on you, and he has been furnished with a complete report of the results which you lack.

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Hoping that you may have the opportunity to talk with Mr. Putnam when he calls on you in Tulsa, we are—

Yours very truly,

Dowell Incorporated,

JWH:JL J. W. Harris, Sales Department.

(Letterhead of Gypsy Oil Company, Tulsa, Okla.)

(Stamped): Dow Rec'd 1933 Jan 21 AM 9 01.

January 19, 1933.

Dowell Incorporated,
Midland, Michigan.

Gentlemen: We have noted with interest the result of acid treatment as applied to oil wells, and the rapid spread of this method of treatment throughout the Mid-Continent area.

We have in mind the possibility of treating certain of our wells in the State of Kansas, and in this connection would like to know whether or not your company will be prepared to service wells in that area within the near future. If you have a specific plan formulated, we would like to know the date on which your service will be available.

Very truly yours,

S. G. Sanderson,
General Superintendent.

TABLE I

Metal strips of strap iron (Series D and B) approximately 1" x 7/8" x 1/8" were used. The solutions were not agitated. The experiments were carried out at 85°F., the volume of the acid solution used per test was 50 cc., and the time of the tests was 16 hours.

Series D	% Hydrochloric Acid		Initial Weight (Grams)	Final Weight (Grams)	Loss in Weight (Grams)	% Loss in Weight	% Reduction in Corrosiveness
Sample 8 (Stella Wilcox)	14.8		14.4300	14.1386	0.2914	2.02	
" " " "	14.8		14.4282	14.1371	0.2911	2.02	
" " " "	14.8		14.4341	14.1487	0.2854	1.98	
		Average	14.4308	14.1415	0.2893	2.01	47
Blank 8 (C. P. HCl)	14.8		14.4407	13.8942	0.5465	3.78	
" " " "	14.8		14.4080	13.8667	0.5413	3.76	
" " " "	14.8		14.4375	13.8840	0.5535	3.83	
		Average	14.4287	13.8816	0.5471	3.79	—
Sample 12-B (Zahn)	14.5		14.6236	14.3606	0.2630	1.80	
" " "	14.5		14.6142	14.3493	0.2649	1.81	
" " "	14.5		14.6131	14.3490	0.2641	1.81	
		Average	14.6170	14.3530	0.2640	1.81	48
Blank 12-B (C.P. HCl)	14.5		14.6114	14.1134	0.4980	3.41	
" " " "	14.5		14.6136	14.1192	0.4944	3.38	
" " " "	14.5		14.6004	14.0748	0.5256	3.60	
		Average	14.6085	14.1025	0.5060	3.46	—
Series B							
Sample 5 (Stella Wilcox)	14.8		14.3847	13.9196	0.4651	3.23	
" " " "	14.8		14.2756	13.8045	0.4711	3.30	
" " " "	14.8		14.1528	13.6974	0.4554	3.22	
		Average	14.2710	13.8072	0.4639	3.25	42
Sample 6 (Stella Wilcox)	14.8		14.3080	13.8577	0.4503	3.15	
" " " "	14.8		14.1734	13.7261	0.4473	3.16	
" " " "	14.8		14.4104	13.9486	0.4618	3.20	
		Average	14.2973	13.8441	0.4531	3.17	43
Average of 5 and 6					0.4585		42.5
Blank 5-6 (C.P. HCl)	14.8		14.3526	13.5577	0.7949	5.54	
" " " "	14.8		14.4171	13.6118	0.8053	5.59	
" " " "	14.8		14.2457	13.4500	0.7957	5.58	
		Average	14.3385	13.5398	0.7986	5.57	—
Sample 12 (Zahn)	14.5		14.3540	13.9100	0.4440	3.09	
" " "	14.5		14.4121	13.9482	0.4639	3.22	
" " "	14.5		14.2618	13.8079	0.4539	3.18	
		Average	14.3426	13.8887	0.4539	3.16	42
Blank 12 (C.P. HCl)	14.5		14.4024	13.6256	0.7768	5.39	
" " " "	14.5		14.4582	13.6765	0.7817	5.41	
" " " "	14.5		14.4568	13.6708	0.7860	5.44	
		Average	14.4391	13.6576	0.7815	5.41	—
Sample 15 (Crawford) 8-23-39	15.2		14.3987	14.1542	0.2445	1.70	
" " " "	15.2		14.1081	13.8552	0.2529	1.79	
" " " "	15.2		14.1509	13.8926	0.2583	1.82	

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" " " "	14.8					
" " " "	14.8	14.1734	13.7261	0.4473	3.16	
		14.4104	13.9486	0.4618	3.20	
		Average 14.2973	13.8441	0.4531	3.17	43
Average of 5 and 6				0.4585		42.5
Blank 5-6 (C.P. HCl)	14.8	14.3526	13.5577	0.7949	5.54	
" " " "	14.8	14.4171	13.6118	0.8053	5.59	
" " " "	14.8	14.2457	13.4500	0.7957	5.58	
		Average 14.3385	13.5398	0.7986	5.57	—
Sample 12 (Zahn)	14.5	14.3540	13.9100	0.4440	3.09	
" " "	14.5	14.4121	13.9482	0.4639	3.22	
" " "	14.5	14.2618	13.8079	0.4539	3.18	
		Average 14.3426	13.8887	0.4539	3.16	42
Blank 12 (C.P. HCl)	14.5	14.4024	13.6256	0.7768	5.39	
" " " "	14.5	14.4582	13.6765	0.7817	5.41	
" " " "	14.5	14.4568	13.6708	0.7860	5.44	
		Average 14.4391	13.6576	0.7815	5.41	—
Sample 15 (Crawford) 8-23-39	15.2	14.3987	14.1542	0.2445	1.70	
" " " "	15.2	14.1081	13.8552	0.2529	1.79	
" " " "	15.2	14.1509	13.8926	0.2583	1.82	
		Average 14.2192	13.9673	0.2519	1.77	69
Sample 15 (Crawford) 8-31-39	15.2	14.3501	14.1053	0.2448	1.71	
" " " "	15.2	14.2577	14.0275	0.2302	1.61	
" " " "	15.2	14.3102	14.0685	0.2417	1.69	
		Average 14.3060	14.0671	0.2389	1.67	71
Average of 15				0.2454		70
Blank 15 (C.P. HCl)	15.2	14.3538	13.5342	0.8196	5.71	
" " " "	15.2	14.1188	13.3038	0.8150	5.77	
" " " "	15.2	14.3114	13.4929	0.8185	5.72	
		Average 14.2613	13.4436	0.8177	5.73	—

TABLE II

ACID CORROSION TESTS

Metal Strips from an oil well pipe of the National Supply Company approximately 1" x 7/8" x 3/16" were used. The solutions were not agitated. The experiments were carried out at 85° F., the volume of the acid solution used per test was 50 cc., and the time of the tests was 16 hours.

	% Hydrochloric Acid		Initial Weight (Grams)	Final Weight (Grams)	Loss in Weight (Grams)	% Loss in Weight	% Reduction in Corrosiveness
Sample 5 (Stella Wilcox)	14.8		20.9523	20.5500	0.4023	1.92	
" " " "	14.8		18.9880	18.5954	0.3926	2.07	
" " " "	14.8		21.0014	20.5900	0.4114	1.96	
		Average	20.3139	19.9118	0.4021	1.98	25
Sample 6 (Stella Wilcox)	14.8		19.3654	18.9608	0.4046	2.09	
" " " "	14.8		20.7884	20.3645	0.4239	2.04	
" " " "	14.8		19.0534	18.6746	0.3788	1.99	
" " " "	14.8		19.4437	19.0704	0.3733	1.92	
		Average	19.6627	19.2676	0.3952	2.01	24
Sample 8 (Stella Wilcox)	14.8		19.1848	18.8046	0.3802	1.98	
" " " "	14.8		19.1752	18.7907	0.3845	2.00	
" " " "	14.8		19.1166	18.7400	0.3766	1.97	
		Average	19.1589	18.7784	0.3804	1.98	25
Average of 5, 6 and 8					0.3926		25
Blank 5-6-8 (C.P. HCl)	14.8		19.3808	18.8664	0.5144	2.66	
" " " "	14.8		19.4710	18.9650	0.5060	2.60	
" " " "	14.8		20.6994	20.1729	0.5265	2.54	
" " " "	14.8		19.1257	18.6350	0.4907	2.56	
" " " "	14.8		19.1594	18.6472	0.5122	2.67	
" " " "	14.8		19.0673	18.5460	0.5213	2.73	
		Average	19.4839	18 9721	0.5118	2.63	—
Sample 12 (Zahn)	14.5		17.9335	17.5702	0.3633	2.03	
" " "	14.5		16.7113	16.3792	0.3321	1.99	
" " "	14.5		21.6454	21.2548	0.3906	1.80	
		Average	18.7634	18.4014	0.3620	1.94	23
Sample 12-B (Zahn)	14.5		18.9359	18.5833	0.3526	1.86	
" " "	14.5		18.9569	18.6074	0.3495	1.84	
" " "	14.5		18.9050	18.5472	0.3578	1.89	
" " "	14.5		18.6880	18.3383	0.3497	1.87	
		Average	18.8714	18.5190	0.3524	1.86	26
Average of 12 and 12-B					0.3572		24.5
Blank 12-12-B (C.P. HCl)	14.5		19.5891	19.1114	0.4777	2.44	
" " " "	14.5		18.1447	17.6659	0.4788	2.64	
" " " "	14.5		18.3639	17.9077	0.4562	2.48	
" " " "	14.5		18.9834	18.5066	0.4768	2.51	
" " " "	14.5		18.9287	18.4288	0.4999	2.64	
" " " "	14.5		18.9680	18.5024	0.4656	2.45	
		Average	18.8296	18.3538	0.4758	2.53	—
Sample 15 (Crawford) 8-23-39	15.2		16.8811	16.6213	0.2598	1.54	
" " "	15.2		16.9076	16.6521	0.2555	1.51	
" " "	15.2		18.4502	18.1831	0.2671	1.45	

" " "	14.5		16.7113	16.3792	0.3321	1.99	
" " "	14.5		21.6454	21.2548	0.3906	1.80	
		Average	18.7634	18.4014	0.3620	1.94	23
Sample 12-B (Zahn)	14.5		18.9359	18.5833	0.3526	1.86	
" " "	14.5		18.9569	18.6074	0.3495	1.84	
" " "	14.5		18.9050	18.5472	0.3578	1.89	
" " "	14.5		18.6880	18.3383	0.3497	1.87	
		Average	18.8714	18.5190	0.3524	1.86	26
Average of 12 and 12-B					0.3572		24.5
Blank 12-12-B (C.P. HCl)	14.5		19.5891	19.1114	0.4777	2.44	
" " " "	14.5		18.1447	17.6659	0.4788	2.64	
" " " "	14.5		18.3639	17.9077	0.4562	2.48	
" " " "	14.5		18.9834	18.5066	0.4768	2.51	
" " " "	14.5		18.9287	18.4288	0.4999	2.64	
" " " "	14.5		18.9680	18.5024	0.4656	2.45	
		Average	18.8296	18.3538	0.4758	2.53	—
Sample 15 (Crawford) 8-23-39	15.2		16.8811	16.6213	0.2598	1.54	
" " "	15.2		16.9076	16.6521	0.2555	1.51	
" " "	15.2		18.4502	18.1831	0.2671	1.45	
			17.4130	17.1522	0.2608	1.50	43
Sample 15 (Crawford) 8-31-39	15.2		18.5377	18.2760	0.2617	1.41	
" " "	15.2		18.6654	18.3908	0.2746	1.47	
" " "	15.2		18.3411	18.0969	0.2442	1.33	
		Average	18.5147	18.2546	0.2602	1.40	47
Average of 15					0.2605		45
Blank 15 (C.P. HCl)	15.2		19.0300	18.5184	0.5116	2.69	
" " " "	15.2		19.5733	19.0547	0.5186	2.65	
" " " "	15.2		18.5200	18.0251	0.4949	2.67	
" " " "	15.2		19.0408	18.5354	0.5054	2.65	
" " " "	15.2		19.0202	18.5312	0.4890	2.57	
" " " "	15.2		19.5732	19.0660	0.5072	2.59	
		Average	19.1262	18.6218	0.5044	2.64	—

TABLE III

ACID CORROSION TESTS

Metal Strips from an oil well pipe of the Oil Well Supply Company approximately 1" x 7/8" x 3/16" were used. The solutions were not agitated. The experiments were carried out at 85° F., the volume of the acid solution used per test was 50 cc., and the time of the tests was 16 hours.

	% Hydrochloric Acid		Initial Weight (Grams)	Final Weight (Grams)	Loss in Weight (Grams)	% Loss in Weight	% Reduction in Corrosiveness
Sample 5 (Stella Wilcox)	14.8		19.9353	19.3546	0.5807	2.91	
" " " "	14.8		19.0582	18.4846	0.5736	3.01	
" " " "	14.8		18.8018	18.2534	0.5484	2.92	
		Average	19.2651	18.6975	0.5676	2.95	36
Sample 6 (Stella Wilcox)	14.8		19.0060	18.4466	0.5594	2.94	
" " " "	14.8		20.2977	19.6902	0.6075	2.99	
" " " "	14.8		19.3068	18.7338	0.5730	2.97	
		Average	19.5368	18.9569	0.5800	2.97	35
Sample 8 (Stella Wilcox)	14.8		18.9647	18.3767	0.5880	3.10	
" " " "	14.8		19.6200	19.0083	0.6117	3.12	
" " " "	14.8		18.4816	17.8917	0.5899	3.19	
		Average	19.0221	18.4256	0.5965	3.14	32
Average of 5, 6 and 8					0.5814		34
Blank 5-6-8 (C.P. HCl)	14.8		19.5763	18.6750	0.9013	4.60	
" " "	14.8		19.1767	18.2696	0.9071	4.73	
" " "	14.8		19.0253	18.1640	0.8613	4.53	
" " "	14.8		18.8671	18.0217	0.8454	4.48	
" " "	14.8		18.2470	17.3904	0.8566	4.69	
" " "	14.8		18.6431	17.8031	0.8400	4.51	
		Average	18.9226	18.0540	0.8686	4.59	—
Sample 12 (Zahn)	14.5		19.0021	18.4468	0.5553	2.92	
" " "	14.5		19.1705	18.6055	0.5650	2.95	
" " "	14.5		18.4762	17.9037	0.5725	3.10	
		Average	18.8829	18.3187	0.5643	2.99	27
Sample 12-B (Zahn)	14.5		18.2172	17.7005	0.5167	2.84	
" " "	14.5		20.2934	19.7279	0.5655	2.79	
		Average	19.2553	18.7142	0.5411	2.82	31
Average of 12 and 12-B					0.5527		29
Blank 12-12-B (C.P. HCl)	14.5		19.7102	18.8954	0.8148	4.13	
" " "	14.5		19.3836	18.5927	0.7909	4.08	
" " "	14.5		20.3652	19.5444	0.8208	4.03	
" " "	14.5		18.2667	17.5143	0.7524	4.12	
" " "	14.5		19.6882	18.8753	0.8129	4.13	
" " "	14.5		20.5504	19.7218	0.8286	4.03	
		Average	19.6607	18.8573	0.8034	4.09	—
Sample 15 (Crawford) 8-31-39	15.2		19.6722	19.2457	0.4265	2.17	
" " "	15.2		19.1750	18.7457	0.4293	2.24	
" " "	15.2		19.7750	19.3366	0.4384	2.22	
		Average	19.5407	19.1093	0.4314	2.21	54
Sample 15 (Crawford) 8-23-39	15.2		18.4876	18.0425	0.4451	2.41	

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" " "	14.5		18.4762	17.9037	0.5725	3.10	
		Average	18.8829	18.3187	0.5643	2.99	27
Sample 12-B (Zahn)	14.5		18.2172	17.7005	0.5167	2.84	
" " "	14.5		20.2934	19.7279	0.5655	2.79	
		Average	19.2553	18.7142	0.5411	2.82	31
Average of 12 and 12-B					0.5527		29
Blank 12-12-B (C.P. HCl)	14.5		19.7102	18.8954	0.8148	4.13	
" " "	14.5		19.3836	18.5927	0.7909	4.08	
" " "	14.5		20.3652	19.5444	0.8208	4.03	
" " "	14.5		18.2667	17.5143	0.7524	4.12	
" " "	14.5		19.6882	18.8753	0.8129	4.13	
" " "	14.5		20.5504	19.7218	0.8286	4.03	
		Average	19.6607	18.8573	0.8034	4.09	—
Sample 15 (Crawford) 8-31-39	15.2		19.6722	19.2457	0.4265	2.17	
" " "	15.2		19.1750	18.7457	0.4293	2.24	
" " "	15.2		19.7750	19.3366	0.4384	2.22	
		Average	19.5407	19.1093	0.4314	2.21	54
Sample 15 (Crawford) 8-23-39	15.2		18.4876	18.0425	0.4451	2.41	
" " "	15.2		18.2342	17.8040	0.4302	2.36	
" " "	15.2		19.9679	19.5059	0.4620	2.31	
		Average	18.8966	18.4508	0.4458	2.36	51
Average of 15					0.4386		52.5
Blank 15 (C.P. HCl)	15.2		18.8353	17.9192	0.9161	4.86	
" " "	15.2		20.2051	19.2449	0.9602	4.75	
" " "	15.2		19.5647	18.6332	0.9315	4.76	
" " "	15.2		18.4148	17.5202	0.8946	4.86	
" " "	15.2		18.2444	17.3691	0.8753	4.80	
" " "	15.2		19.4536	18.5266	0.9270	4.75	
		Average	19.1196	18.2022	0.9174	4.80	—

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TABLE IV

ACID CORROSION TESTS

Metal strips from an oil well pipe of the Atha Supply Company approximately 1" x 7/8" x 3/16" were used. The solutions were not agitated. The experiments were carried out at 85° F., the volume of the acid solution used per test was 50 cc., and the time of the tests was 16 hours.

	% Hydrochloric Acid		Initial Weight (Grams)	Final Weight (Grams)	Loss in Weight (Grams)	% Loss in Weight	% Reduction in Corrosiveness
Sample 5 (Stella Wilcox)	14.8		20.7069	20.2526	0.4543	2.19	
" " " "	14.8		20.7511	20.2998	0.4513	2.17	
" " " "	14.8		20.5949	20.1592	0.4357	2.12	
		Average	20.6843	20.2372	0.4471	2.16	38
Sample 6 (Stella Wilcox)	14.8		20.6017	20.1583	0.4434	2.15	
" " " "	14.8		21.3841	20.9261	0.4580	2.14	
		Average	20.9929	20.5422	0.4507	2.14	39
Sample 8 (Stella Wilcox)	14.8		20.3989	19.8683	0.5306	2.60	
" " " "	14.8		20.6135	20.0934	0.5201	2.52	
" " " "	14.8		20.5046	19.9832	0.5214	2.54	
		Average	20.5057	19.9816	0.5240	2.55	27
Average of 5, 6 and 8					0.4739		35
Blank 5-6-8 (C.P. HCl)	14.8		20.8553	20.1248	0.7305	3.50	
" " "	14.8		20.6635	19.9217	0.7418	3.59	
" " "	14.8		20.8786	20.1619	0.7167	3.43	
" " "	14.8		21.2656	20.5308	0.7348	3.45	
" " "	14.8		20.4314	19.7291	0.7023	3.44	
		Average	20.8189	20.0937	0.7252	3.48	—
Sample 12 (Zahn)	14.5		21.9644	21.4954	0.4690	2.13	
" " "	14.5		21.0874	20.6017	0.4857	2.30	
" " "	14.5		20.6899	20.2377	0.4522	2.19	
		Average	21.2472	20.7783	0.4690	2.21	34
Sample 12-B (Zahn)	14.5		19.6432	19.2835	0.3597	1.83	
" " "	14.5		20.3731	19.9933	0.3798	1.86	
		Average	20.0081	19.6384	0.3698	1.84	45
Average of 12 and 12-B					0.4194		39.5
Blank 12-12-B (C.P. HCl)	14.5		20.8167	20.1260	0.6907	3.32	
" " "	14.5		20.6086	19.9212	0.6874	3.33	
" " "	14.5		20.3016	19.6205	0.6811	3.35	
" " "	14.5		20.2327	19.5626	0.6701	3.31	
" " "	14.5		20.4971	19.8035	0.6936	3.38	
		Average	20.4913	19.8068	0.6846	3.34	—
Sample 15 (Crawford) 8-23-39	15.2		20.5120	20.3674	0.1446	0.70	
" " " "	15.2		20.4339	20.3137	0.1202	0.59	
" " " "	15.2		21.2896	21.1128	0.1768	0.83	
		Average	20.7452	20.5980	0.1472	0.71	81
Sample 15 (Crawford) 8-31-39	15.2		22.6972	22.5202	0.1770	0.78	
" " " "	15.2		20.3798	20.2462	0.1336	0.65	
" " " "	15.2		23.4647	23.2498	0.2149	0.92	

		Average	21.2472	20.7783	0.4690	2.21	34
Sample 12-B (Zahn)	14.5		19.6432	19.2835	0.3597	1.83	
" " "	14.5		20.3731	19.9933	0.3798	1.86	
		Average	20.0081	19.6384	0.3698	1.84	45
Average of 12 and 12-B					0.4194		39.5
Blank 12-12-B (C.P. HCl)	14.5		20.8167	20.1260	0.6907	3.32	
" " "	14.5		20.6086	19.9212	0.6874	3.33	
" " "	14.5		20.3016	19.6205	0.6811	3.35	
" " "	14.5		20.2327	19.5626	0.6701	3.31	
" " "	14.5		20.4971	19.8035	0.6936	3.38	
		Average	20.4913	19.8068	0.6846	3.34	—
Sample 15 (Crawford) 8-23-39	15.2		20.5120	20.3674	0.1446	0.70	
" " " "	15.2		20.4339	20.3137	0.1202	0.59	
" " " "	15.2		21.2896	21.1128	0.1768	0.83	
		Average	20.7452	20.5980	0.1472	0.71	81
Sample 15 (Crawford) 8-31-39	15.2		22.6972	22.5202	0.1770	0.78	
" " " "	15.2		20.3798	20.2462	0.1336	0.65	
" " " "	15.2		23.4647	23.2498	0.2149	0.92	
		Average	22.1806	22.0054	0.1752	0.78	79
Average of 15					0.1612		80
Blank 15 (C.P. HCl)	15.2		20.6579	19.8899	0.7680	3.72	
" " "	15.2		21.7769	20.9629	0.8140	3.74	
" " "	15.2		20.3977	19.6142	0.7835	3.84	
" " "	15.2		20.7252	19.9493	0.7759	3.74	
" " "	15.2		20.7871	20.0147	0.7724	3.72	
		Average	20.8690	20.0862	0.7828	3.75	—

TABLE VII

ACID CORROSION TESTS

Metal strips of strap iron, series D, approximately 1" x 7/8" x 1/8" were used. The solutions were not agitated. The experiments were carried out at 85° F., the volume of the acid solution used per test was 50 cc., and the time of the tests was 16 hours.

	% Hydrochloric Acid		Initial Weight (Grams)	Final Weight (Grams)	Loss in Weight (Grams)	% Loss in Weight	% Reduction in Corrosiveness
Sample N-14-B Diluted to	14.5		14.5279	14.0619	0.4660	3.21	7.2
Sample S-14-B Diluted to	14.5		14.7580	14.2727	0.4853	3.29	4.9
Blank of Diluted N-14-B and S-14-B (C.P. HCl)	14.5		14.6114	14.1134	0.4980	3.41	
"	14.5		14.6136	14.1192	0.4944	3.38	
"	14.5		14.6004	14.0748	0.5256	3.60	
		Average	14.6085	14.1025	0.5060	3.46	—
Sample N-20-B Diluted to	15.1		14.7282	14.2555	0.4727	3.21	
"	15.1		14.4927	14.0221	0.4706	3.25	
		Average	14.6104	14.1388	0.4716	3.23	11.3
Sample S-20-B Diluted to	15.1		14.3950	13.9121	0.4829	3.35	
"	15.1		14.3615	13.8781	0.4834	3.37	
		Average	14.3782	13.8951	0.4832	3.36	7.7
Blank of Diluted N-20-B and S-20-B (C.P. HCl)	15.1		14.4905	13.9644	0.5261	3.63	
"	15.1		14.5299	14.0036	0.5263	3.62	
"	15.1		14.4529	13.9221	0.5308	3.67	
"	15.1		14.4434	13.9173	0.5261	3.64	
		Average	14.4792	13.9518	0.5273	3.64	—

TABLE VIII

ACID CORROSION TESTS

Metal Strips from an oil well pipe of the National Supply Company approximately 1" x 7/8" x 3/16" were used. The solutions were not agitated. The experiments were carried out at 85° F., the volume of the acid solution used per test was 50 cc., and the time of the tests was 16 hours.

	% Hydrochloric Acid		Initial Weight (Grams)	Final Weight (Grams)	Loss in Weight (Grams)	% Loss in Weight	% Reduction in Corrosiveness
Sample N-14-B Diluted to	14.5		18.0529	17.6306	0.4223	2.34	7.5
Sample S-14-B Diluted to	14.5		17.9273	17.4922	0.4351	2.43	4.0
Blank of Diluted N-14-B and S-14-B (C.P. HCl)	14.5		19.5891	19.1114	0.4777	2.44	
"	14.5		18.1447	17.6659	0.4788	2.64	
"	14.5		18.3639	17.9077	0.4562	2.48	
"	14.5		18.9834	18.5066	0.4768	2.51	
"	14.5		18.9287	18.4288	0.4999	2.64	
"	14.5		18.9680	18.5024	0.4656	2.45	
		Average	18.8296	18.3538	0.4758	2.53	—
Sample N-20-B Diluted to	15.1		19.4419	18.9868	0.4551	2.34	
"	15.1		17.9398	17.5163	0.4235	2.36	
		Average	18.6908	18.2516	0.4393	2.35	15.5
Sample S-20-B Diluted to	15.1		19.3011	18.8152	0.4859	2.52	
"	15.1		17.8251	17.3721	0.4530	2.54	
		Average	18.5631	18.0936	0.4694	2.53	9.0
Blank of Diluted N-20-B and S-20-B (C.P. HCl)	15.1		18.6084	18.0928	0.5156	2.77	
"	15.1		18.6948	18.1811	0.5137	2.75	
"	15.1		18.6908	18.1980	0.4928	2.64	
"	15.1		18.8523	18.3351	0.5172	2.74	
"	15.1		18.8956	18.3789	0.5167	2.73	
"	15.1		18.8080	18.2826	0.5254	2.79	
"	15.1		17.9263	17.4172	0.5091	2.84	
"	15.1		17.9937	17.4807	0.5130	2.85	
"	15.1		17.9413	17.4269	0.5144	2.87	
		Average	18.4901	17.9770	0.5131	2.78	—

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TABLE XI

ANALYSIS MADE OF HALLIBURTON TRUCK ACID SAMPLES

Sample	% Hydrochloric Acid	Copper p.p.m.	Lead p.p.m.	Iron p.p.m.
5 Stelia Wilcox	14.8	2.9	410	480
6 Stella Wilcox	14.8	3.6	420	470
8 Stella Wilcox	14.8	4.2	420	470
Average Stella Wilcox	14.8	3.6	417	473
12 Zahn	14.5	2.7	410	410
12-B Zahn	14.5	3.5	460	350
Average Zahn	14.5	3.1	435	380
15 Crawford 8-23-39	15.2	4.5	48	210
15 Crawford 8-31-39	15.2	5.0	58	210
Average Crawford	15.2	4.8	53	210
Average Metal Content of Stella Wilcox, Zahn and Crawford Samples		3.8	302	354

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TABLE XII

ANALYSIS MADE OF HALLIBURTON STORAGE TANK ACID SAMPLES

Sample	% Hydrochloric Acid	Copper p.p.m.	Lead p.p.m.	Iron p.p.m.
N-14-B	28.5	1.5	10	27
S-14-B	29.3	1.5	8.7	13
N-20-B	30.3	0.37	5.5	15
S-20-B	30.7	0.56	16	21
Average		0.98	10	19

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TABLE XIII

ANALYSIS MADE OF DILUTED HALLIBURTON STORAGE TANK ACID SAMPLES

Sample	% Hydrochloric Acid	Copper p.p.m.	Lead p.p.m.	Iron p.p.m.
N-14-B Diluted to	14.5	0.72	4.8	13
S-14-B Diluted to	14.5	0.69	4.0	6.0
N-20-B Diluted to	15.1	0.17	2.6	7.0
S-20-B Diluted to	15.1	0.26	7.3	9.6
Average		0.46	4.7	8.9

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TABLE XIV

COMPARISON OF THE METAL CONTENT OF THE ZAHN WELL SAMPLES NOS. 12 AND 12-B, AND THE DILUTED STORAGE SAMPLES N-14-B AND S-14-B

Sample	% Hydrochloric Acid	Copper p.p.m.	Lead p.p.m.	Iron p.p.m.
12 Zahn	14.5	2.7	410	410
12-B Zahn	14.5	3.5	460	350
Average	14.5	3.1	435	380
N-14-B Diluted to	14.5	0.72	4.8	13
S-14-B Diluted to	14.5	0.69	4.0	6.0
Average	14.5	0.70	4.4	9.5
The ratio of the average metal content of the Zahn samples to the average metal content of the diluted storage samples N-14-B and S-14-B		4 : 1	99 : 1	40 : 1

PLAINTIFF'S EXHIBIT 164

TABLE XV

COMPARISON OF THE METAL CONTENT OF THE STELLA WILCOX SAMPLES NOS. 5, 6 AND 8, AND THE DILUTED STORAGE SAMPLES N-14-B AND S-14-B

Sample	% Hydrochloric Acid	Copper p.p.m.	Lead p.p.m.	Iron p.p.m.
5 Stella Wilcox	14.8	2.9	410	480
6 Stella Wilcox	14.8	3.6	420	470
8 Stella Wilcox	14.8	4.2	420	470
Average	14.8	3.6	417	473
N-14-B Diluted to	14.5	0.72	4.8	13
S-14-B Diluted to	14.5	0.69	4.0	6.0
Average	14.5	0.70	4.4	9.5
The ratio of the average metal content of the Stella Wilcox samples to the average metal content of the diluted storage samples N-14-B, and S-14-B		5 : 1	95 : 1	50 : 1

PLAINTIFF'S EXHIBIT 165

TABLE XVI

COMPARISON OF THE METAL CONTENT OF THE CRAWFORD SAMPLES 15, AND THE DILUTED STORAGE SAMPLES N-14-B, S-14-B, N-20-B AND S-20-B.

Sample	% Hydrochloric Acid	Copper p.p.m.	Lead p.p.m.	Iron p.p.m.
15 Crawford 8-23-39	15.2	4.5	48	210
15 Crawford 8-31-39	15.2	5.0	58	210
Average	15.2	4.8	53	210
N-14-B Diluted to	14.5	0.72	4.8	13
S-14-B Diluted to	14.5	0.69	4.0	6.0
N-20-B Diluted to	15.1	0.17	2.6	7.0
S-20-B Diluted to	15.1	0.26	7.3	9.6
Average	...	0.46	4.7	8.9
The ratio of the average metal content of the Crawford samples to the average metal content of the diluted storage samples N-14-B, S-14-B, N-20-B and S-20-B		10 : 1	11 : 1	24 : 1

PLAINTIFF'S EXHIBIT 166

TABLE XVIII

ACID CORROSION TESTS

Acid corrosion tests at 85° F.. using strap iron and 50 cc. of 15.1% C.P. hydrochloric acid solutions containing different amounts of copper, lead, and iron. The solutions were not agitated. The tests required a period of 16 hours.

Solution Number	Copper p.p.m.	Lead p.p.m.	Ferric Iron p.p.m.	Ferrous Iron p.p.m.	% Reduction In Corrosiveness
1	1.0	—	—	—	20
2	3.5	—	—	—	33
3	5.0	—	—	—	37
4	10.0	—	—	—	38
5	40.0	—	—	—	39
6	80.0	—	—	—	40
7	100.0	—	—	—	40
8	—	10	—	—	4
9	—	40	—	—	3
10	—	160	—	—	6
11	—	320	—	—	12
12	—	420	—	—	13
13	—	620	—	—	14
14	—	1000	—	—	15
15	—	—	300	—	1
16	—	—	440	—	3
17	—	—	700	—	4
18	—	—	1000	—	4
19	—	—	—	300	0
20	—	—	—	440	0
21	—	—	—	700	1
22	—	—	—	1000	0
23	3.5	10	—	—	36
24	3.5	40	—	—	38

Plaintiff's Exhibit 166

Solution Number	Copper p.p.m.	Lead p.p.m.	Ferric Iron p.p.m.	Ferrous Iron p.p.m.	% Reduction In Corrosiveness
25	3.5	160	—	—	38
26	3.5	320	—	—	38
27	3.5	420	—	—	38
28	3.5	620	—	—	40
29	3.5	1000	—	—	41
30	3.5	—	300	—	33
31	3.5	—	440	—	34
32	3.5	—	700	—	33
33	3.5	—	1000	—	34
34	3.5	—	—	300	34
35	3.5	—	—	440	34
36	3.5	—	—	700	33
37	3.5	—	—	1000	34
38	1.0	420	—	—	30
39(27)	3.5	420	—	—	38
40	5.0	420	—	—	40
41	10.0	420	—	—	41
42	40.0	420	—	—	42
43	80.0	420	—	—	42
44	100.0	420	—	—	43
45	—	420	300	—	12
46	—	420	440	—	14
47	—	420	700	—	12
48	—	420	1000	—	12
49	—	420	—	300	11
50	—	420	—	440	11
51	—	420	—	700	10
52	—	420	—	1000	9
53	1.0	—	440	—	20
54(31)	3.5	—	440	—	34
55	5.0	—	400	—	38
56	10.0	—	440	—	38
57	40.0	—	440	—	40
58	80.0	—	440	—	38
59	100.0	—	440	—	37

Plaintiff's Exhibit 166

Solution Number	Copper p.p.m.	Lead p.p.m.	Ferric Iron p.p.m.	Ferrous Iron p.p.m.	% Reduction In Corrosiveness
60	——	10	440	——	0
61	——	40	440	——	6
62	——	160	440	——	9
63	——	320	440	——	14
64(46)	——	420	440	——	14
65	——	620	440	——	17
66	——	1000	440	——	17
67	3.5	420	300	——	39
68	3.5	420	440	——	40
69	3.5	420	700	——	38
70	3.5	420	1000	——	38
71	3.5	10	440	——	34
72	3.5	40	440	——	37
73	3.5	160	440	——	36
74	3.5	320	440	——	37
75(68)	3.5	420	440	——	40
76	3.5	620	440	——	40
77	3.5	1000	440	——	40
78	1.0	420	440	——	30
79(68)(75)	3.5	420	440	——	40
80	5.0	420	440	——	39
81	10.0	420	440	——	41
82	40.0	420	440	——	40
83	80.0	420	440	——	42
84	100.0	420	440	——	42
85	3.5	420	...	440	39

PLAINTIFF'S EXHIBIT 167

TABLE XIX

ACID CORROSION TESTS

Acid corrosion tests at 85°F., using strap iron, Series J.
The tests required a period of 16 hours.

Solution Number	Characteristics of Solution			Reduction in Corrosiveness		
	Acid	Added Metals Parts per million Copper	Lead	Iron	50 cc. of Solution With No Agitation	50 cc. of Solution With Agitation	300 cc. of Solution With Agitation
2	15.1% C.P. HCl	3.5	None	None	33%	44%	63%
26	15.1% C.P. HCl	3.5	320	None	38%	48%	63%
30	15.1% C.P. HCl	3.5	None	300 (ferric)	33%	43%	64%
34	15.1% C.P. HCl	3.5	None	300 (ferrous)	34%	43%	64%
68	15.1% C.P. HCl	3.5	420	440 (ferric)	40%	52%	63%
85	15.1% C.P. HCl	3.5	420	440 (ferrous)	39%	50%	65%

PLAINTIFF'S EXHIBIT 169

DR. BARTELL'S DATA

COPPER, LEAD AND IRON CONTENT IN GRAMS PER 1000 GALLONS OF DEFENDANTS HYDROCHLORIC ACID SAMPLES

	Storage Acids			Truck Acids	
	Sample N-14-B Taken Aug. 18, 1938 Diluted to 14.5% Acid	Sample S-14-B Taken Aug. 18, 1938 Diluted to 14.5% Acid	Average	Stella Wilcox Treated Aug. 5, 1938 14.8% Acid	Zahn Treated Aug. 19, 1938 14.5% Acid
Copper	3.1 gms.	3.0 gms.	3.05 gms.	15 gms.	13 gms.
	0.72 p.p.m.	0.69 p.p.m.	0.70 p.p.m.	3.6 p.p.m.	3.1 p.p.m.
Lead	21 gms.	17 gms.	19 gms.	1700 gms.	1800 gms.
	4.8 p.p.m.	4.0 p.p.m.	4.4 p.p.m.	417 p.p.m.	435 p.p.m.
Iron	56 gms.	26 gms.	41 gms.	1900 gms.	1500 gms.
	13 p.p.m.	6.0 p.p.m.	9.5 p.p.m.	473 p.p.m.	380 p.p.m.

	Sample N-20-B Taken Dec. 6, 1938 Diluted to 15.1% Acid	Sample S-20-B Taken Dec. 6, 1938 Diluted to 15.1% Acid	Average	Crawford Treated Sept. 10, 1938 15.2% Acid
Copper	0.75 gms.	1.1 gms.	0.92 gms.	20 gms.
	0.17 p.p.m.	0.26 p.p.m.	0.21 p.p.m.	4.8 p.p.m.
Lead	11 gms.	32 gms.	21 gms.	220 gms.
	2.6 p.p.m.	7.3 p.p.m.	5.0 p.p.m.	53 p.p.m.
Iron	30 gms.	42 gms.	36 gms.	860 gms.
	7.0 p.p.m.	9.6 p.p.m.	8.3 p.p.m.	210 p.p.m.

No storage acid purchased by defendant between July 24, 1938 and August 27, 1938.

Plaintiff's Exhibit 169

PLAINTIFF'S EXHIBIT 171

BARTELL TABLE X

PERCENTAGE REDUCTION IN CORROSIVENESS OF SOME OF THE GREBE AND SANFORD MATERIALS

The percentages of reduction in corrosiveness were calculated from acid corrosion tests at 85 F., using strap iron Series L, and 50 cc., of acid solutions. The tests required a period of 16 hours. The solutions were not agitated.

Material	% Reduction in Corrosiveness
Saturated Solution of Acridine in 15.1% HCl	41
1% Solution of Aniline in 15.1% HCl	34
3%	60
5%	67
1% Solution of Pyridine in 15.1% HCl	47
3%	60
5%	65
1% Solution of Quinoline in 15.1% HCl	84
3%	84
5%	84

PLAINTIFF'S EXHIBIT 172

HCl ACID RECEIVED BY DEFENDANT AT MT. PLEASANT, MICH., STATION

Date	Amount	Source
April 23, 1938	3,976 gals	Pennsylvania Salt Co.
May 2, 1938	3,914 "	" " "
May 3, 1938	3,945 "	" " "
May 21, 1938	6,075 "	General Chemical Co.
May 23, 1938	5,982 "	" " "
June 15, 1938	5,993 "	" " "
June 15, 1938	7,824 "	" " "
July 24, 1938	6,013 "	" " "

August 2, 1938—Wilcox Well, Samples Nos. 1 and 2. From Halliburton's steel transport tank at well.

August 5, 1938—Wilcox Well, Samples Nos. 5, 6, and 8. From Halliburton's steel transport tank at well.

STORAGE SAMPLES

August 18, 1938, Nos. N-14-B and S-14-B. From Halliburton's wooden storage tanks.

August 19, 1938—Zahn Well, Samples Nos. 12 and 12-B. From Halliburton's steel transport tank at well.

ACID RECEIVED BY DEFENDANT

August 27, 1938 5,938 gals. General Chemical Co.

September 10, 1938—Crawford Well, Sample No. 15 and a second No. 15. From Halliburton's steel transport tank at well.

Plaintiff's Exhibit 172

ACID RECEIVED BY DEFENDANT

October 17, 1938 7,866 gals. General Chemical Co.

STORAGE SAMPLES

December 6, 1938, Nos. N-20-B and S-20-B.
From Halliburton's wooden storage tanks.

April 24, 1939—Knight Well,
From Halliburton's steel transport tank at well.

STORAGE SAMPLES

April 26, 1939, Nos. N-23 and S-23.
From Halliburton's wooden storage tanks.

(PLAINTIFF'S EXHIBIT 173-A)

Acid Sample	Composition of Acid % HCl by Wt.	Concentration in p.p.m. Iron	Lead	Copper	Per Cent Corrosiveness Reduced
1	15.0	0	0	0	100
2	"	473	242	2.14	59.7
3	"	473	242	3.72	70.0
4	"	473	510	1.86	62.8
5	"	473	510	4.18	71.4
6	"	1430	204	1.86	61.1
7	"	1440	530	3.44	70.5

DISCUSSION OF RESULTS AND CONCLUSIONS

1. When iron, copper and lead are dissolved in 15% hydrochloric acid, in the concentrations studied in this work, the corrosiveness of the acid is greatly reduced. The metal contacting acids studied attack the test specimens with 60-70% reduction in corrosiveness when compared to metal free acid.

(PLAINTIFF'S EXHIBIT 173-B)

2. Comparison of the results obtained in tests No. 2 and No. 6 in which the iron content alone differed to any great extent, and also in tests No. 5 and No. 7, shows that increasing the iron from approximately 500 p.p.m. to a value of approximately 1500 did not appreciably change the rate of attack of the 15% hydrochloric acid upon the oil well tubing.

Acid Sample No.	Metallic Content of Acid p.p.m.			Per Cent Corrosiveness Reduced
	Iron	Lead	Copper	
2	473	242	2.14	59.7
6	1430	204	1.86	61.1
5	473	510	4.18	71.4
7	1440	530	3.44	70.5

(PLAINTIFF'S EXHIBIT 173-C)

3. Increasing the lead content of the acid from 242 p.p.m. to 510 p.p.m., and keeping the iron and copper contents substantially constant, reduces slightly the rate of attack of the 15% acid on the oil well tubing, i.e., increases the per cent corrosiveness reduced.

Acid Sample No.	Metallic Content of Acid p.p.m.			Per Cent Corrosiveness Reduced
	Iron	Lead	Copper	
2	473	242	2.14	59.7
4	473	510	1.86	62.8

(PLAINTIFF'S EXHIBIT 173-D)

4. Keeping iron and lead concentrations constant, and increasing the copper content from approximately 2 to 4 parts per million, reduced the corrosiveness of the 15% hydrochloric acid upon the oil well tubing.

Acid Sample No.	Metallic Content of Acid p.p.m.			Per Cent Corrosiveness Reduced
	Iron	Lead	Copper	
2	473	242	2.14	59.7
3	473	242	3.72	70.0

D. Large Scale Tubing Tests

General Procedure

In large scale oil well tubing tests, 15% hydrochloric acid was flowed by gravity for three hours, through 112 feet of 1¼" oil well tubing at a rate of one gallon per minute. The rate of attack of the acid upon the oil well tubing was found by analytical determination of the iron content of the acid entering the tubing and of the acid leaving the tubing during the test.

Details of Equipment

I. Stoneware Crock—

A 200 gallon stoneware crock, having a stoneware spigot in the side close to the bottom, was purchased from M. G. Knight and Company of Akron, Ohio. This crock was thoroughly washed with water and 15% hydrochloric acid before each batch of acid was prepared.

A plate glass cover was obtained to prevent dust or dirt from falling into the acid in the crock during runs. A photograph of this crock is marked Figure I, page 33.

(Plaintiff's Exhibit 173-D)

II. Oil Well Tubing Used—

The 1¼" oil well tubing from the Oil Well Supply Co., previously described was employed in these tests. Five full lengths of this tubing were connected together with couplings provided by the Oil Well Supply Co., and by the elbow which we fabricated from one length of the 1¼" oil well tubing, as described previously.

The tubing used, was given the same cleaning procedure as used in preparing the laboratory test specimens, with the exception that the outside of the tubes were not wirebrushed and the drying was conducted by passing warm air thru the tubing instead of drying in an oven.

Figure 2, page 34, shows the acid crock connected to the tubing system.

III. Hydrogen Vent Tube—

A 1" pyrex glass tube (x) was connected to the spigot in the stoneware crock, by means of a short section of pure gum rubber tubing. The lower end of this glass tube was connected to the upper end of the tubing system at Y, using a rubber stopper. All rubber stoppers and connecting tubing were soaked for two days in 15% hydrochloric acid before use.

The upper end of the glass tube (x) permits the escape of bubbles because it is open and vented into the top of the crock. This glass tube (x) permits the escape of bubbles of hydrogen gas during a run, which are produced when hydrochloric acid reacts upon steel. We were thus assured that tubing system would not become filled with hydrogen gas, which would have greatly reduced the area of contact between the acid and the inside of the tubing.

IV. Control of Rate of Flow of Acid in Tubing—

In Figure 3, page 35, is shown the lower end of the oil well tubing system and the calibrated orifice bottle (P) used to measure the rate of flow of the acid leaving the tub-

ing. A rubber stopper was inserted into the open end of the lower length of oil well tubing. A 1" pyrex glass tube running thru this stopper and connected to a short section of pure gum rubber tubing, carried the acid leaving the tubing into the open top of the calibrated orifice bottle (P).

By means of an adjustable screw clamp (S) on the rubber tubing, the rate of flow of acid out of the tubing could be varied. The orifice bottle (P) indicated the rate of flow of the acid. A short section of glass tubing (N) in the stopper in the lower opening of this bottle, was used as the discharge orifice. If the level of hydrochloric acid in the bottle was maintained at the calibration mark (T), exactly one gallon of acid was discharged from the orifice per minute. By means of the screw clamp (S) the rate of flow of acid from the tubing was adjusted so the level in the bottle was maintained at the mark (T), thus keeping the rate of discharge during a run constant at one gallon per minute.

V. Acid Used—

The acid employed in these tests was commercial hydrochloric acid purchased in glass carboys from the Grasselli division of the du Pont Co., and is manufactured in their Cleveland plant. Analyses of various samples of this acid showed low copper, iron and lead contents. This acid was diluted in the stoneware crock, to 15% hydrochloric acid content by adding Cleveland city tap water.

In several of the tests to be described, ferrous chloride, lead chloride and copper chloride were added to increase the metal content of the diluted acid, to desired values. In all cases, the metal contents of such batches of acid were determined by chemical analysis of the prepared solutions.

VI. Large Scale Test Data—

Two separate sets of oil well tubing were used in the large scale tests. All Series 1 tests, designated 1A, 1AA,

and 1B were made with one set of oil well tubing, with each tube and fitting in exactly the same position for each of these runs.

All series 2 tests, designated 2A, 2B, 2C and 2D, were made with an entirely different set of tubes and fittings. Each tube and fitting occupied the same position in the tubing assembly in each of these Series 2 runs. Tables I, II, III, IV, V, VI, VII, VIII, give the data obtained and calculated results in each of the large scale tests.

Explanation of Tables

In Table I, page 25, data for run No. 1A is shown. In the second column of the table a general description of the run conditions is given. In the third column is recorded the total volume of acid that has passed through the system at the time when acid samples were taken. Under the heading "Samples Taken at Inlet" are listed the samples taken of the acid leaving the crock and their composition as determined by chemical analysis. In Run 1A, an acid sample was taken from the crock at the start of the run, and a second sample after 134.5 gallons of acid had run through the tubing. The average iron content of these two samples is shown in the next column as 9.3 p.p.m.

Under the general heading "Samples Taken at Outlet," are tabulated the indiyidual samples of acid taken at the outlet from the tubing system, how these samples were combined for analysis and the analysis of the combined samples. Thus sample 1 out was taken when 27.5 gallons of acid had passed through tubing. Sample 2 out, after 55.5 gallons total had passed thru. Samples 1 out, 2 out and 3 out were then combined in proper proportion, and the composite or average sample was analyzed for its iron content, shown to be 1135 parts per million. The high iron content shown for the "Initial Out" sample is due to the rapid dissolution of any free iron particles that may be clinging to the interior of the pipe at the start of the runs.

(Plaintiff's Exhibit 173-D)

Calculation of Weight of Iron Dissolved From The Tubing During The Run

In the last column of the Tables I—VIII, pages 25-32, are given the grams of iron dissolved from the oil well tubing during the entire test run. In Run 1A this amounted to 1043 grams of iron and was calculated as follows:

In the accompanying table, page 1733, for the calculation of the iron dissolved from the tubing in Run 1A, the first column gives the number of gallons of acid thru the tubing. The second gives the number of gallons of acid which are represented by the analyzed sample. The third and fourth columns give the iron analysis of the inlet and exit acids in milligrams per cubic centimeter. Parts per million were converted to milligrams per cubic centimeter as follows:

$$\text{mg/cc} = \frac{\text{sp gr. x 1000 x p.p.m}}{}$$

$$\text{mg/cc} = \frac{1.0726 \text{ x p.p.m}}{1.000}$$

e.g.

$$\text{mg Fe/cc} = \frac{1.0726 \text{ x } 9.3}{10^3}$$

$$\text{mg Fe/cc} = 0{,}01$$

The fifth column gives the change in iron concentration of the exit acid over the inlet acid for each period. The last column gives the grams of iron which have been dissolved by the number of gallons of acid in column two. This was calculated as follows:

(Plaintiff's Exhibit 173-D)

The Increase in conc. of iron in mg/cc x cubic centimeters of acid thru tubing

$$\frac{10{,}000}{} = \text{grams fe increase in acid}$$

Since 1 gallon = 3785 cubic centimeters, the calculation would be:

(1) $\dfrac{1.21 \times 76.5 \times 3785}{1000} = 350$ grams

(2) $\dfrac{1.54 \times 58.0 \times 3785}{1000} = 338$ grams

(3) $\dfrac{1.50 \times 62.6 \times 3785}{1000} = 355$ grams

Total increase of iron in acid = 1043 grams

CALCULATION OF WEIGHT OF IRON DISSOLVED FROM OIL WELL TUBING DURING RUN 1A

Gallons of Acid Thru Tubing	Gallons of Acid Thru Tubing Between Samples	mg Fe/cc Inlet Acid	mg Fe/cc Exit Acid	Increase in Conc. mg Fe/cc	Grams Iron dissolved from Tubing
76.5	76.5	0.01	1.22	1.21	350
134.5	58	0.01	1.55	1.54	338
197.1	62.6	0.01	1.51	1.50	355
					1043 Total grams

PLAINTIFF'S EXHIBIT 176

PRUTTON TABLE I

Run	Conditions	Gallons of Acid Thru Tubing Between Samples	Samples Taken At Inlet		Samples Taken At Outlet		Total Grams Increase Fe in Acid
			Sample No.	pp m Fe	Sample No.	pp m Fe	
1A	15% HCl Acid directly from stoneware crock thru tubing. Temperature 85° F. and rate 1 gal. per minute. Series 1 tubing.	0	Initial Crock	9.3	Initial Out	2240	
		27.5			1	1135	
		55.5			2		
		76.5			3		
		95.5			4	1450	
		114.5			5		
		134.5	Crock 2		6		
		152.5			7	1405	
		171.5			8		
		191.5			9		
		197.1			10		1043

PLAINTIFF'S EXHIBIT 177

PRUTTON TABLE II

Run	Conditions	Gallons of Acid Thru Tubing Between Samples	Samples Taken At Inlet		Samples Taken At Outlet		Total Grams Increase Fe in Acid
			Sample No.	ppm Fe	Sample No.	ppm Fe	
1AA	15% HCl acid directly from stoneware crock thru tubing. One gal. per min. at 85° F. Series 1 Tubing	0	Initial Crock		Initial	3540	
		25			1		
		47			2	1180	
		67			3		
		86		4	4		
		105	Crock 2		5	1263	
		125			6		
		146			7		
		168			8	1218	
		183.2			9		
		189.98			10		943

PLAINTIFF'S EXHIBIT 178

PRUTTON TABLE III

Conditions	Gallons of Acid Thru Tubing Between Samples	Samples Taken At Inlet		Samples Taken At Outlet		Total Grams Increase Fe in Acid
		Sample No.	pp m Fe	Sample No.	pp m Fe	
15% HCl acid directly from a stoneware crock to series 2 tubing; temperature 85° F. and rate 1 gal. per minute	0	Initial Crock		Initial Out	3580	
	27			1		
	47			2	1292	
	66		9.3	3		
	85			4		
	104			5	1357	
	126	Crock 2		6		
	144			7		
	159			8	967	
	176			9		
	188.3			10		919

PLAINTIFF'S EXHIBIT 179

PRUTTON TABLE IV

Run	Conditions	Gallons of Acid Thru Tubing Between Samples	Samples Taken At Inlet		Samples Taken At Outlet		Total Grams Increase Fe in Acid
			Sample No.	pp m Fe	Sample No.	pp m Fe	
2C	Acid directly from stoneware crock thru series 2 tubing 1 gallon per minute at 85° F.	0	Crock	7.0	Initial Out	1330	
		27			1		
		46			2	1143	
		64			3		
		84			4		
		102			5	1088	
		121			6		
		142			7		
		161			8	1070	
		178			9		
		178					791

PLAINTIFF'S EXHIBIT 180

PRUTTON TABLE V

Run	Conditions	Gallons of Acid Thru Tubing Between Samples	Samples Taken At Inlet		Samples Taken At Outlet		Total Grams Increase Fe in Acid
			Sample No.	ppm Fe	Sample No.	ppm Fe	
1B	Acid directly from stoneware crock through series 1 tubing. 1 gal. per minute and 85° F. Acid was treated with $CuCl_2$, $PbCl_2$, $FeCl_2$	0	Initial Crock	1682	Initial Out	3250	
		25			1		
		45			2	1990	
		63			3		
	Average Analysis	86			4		
	ppm Pb / ppm Cu	102			5	2010	
	Inlet 390 / 2.79	123.5	Crock 2		6		
		145			7		
		177			8	1942	
		184			9		
		201			10		

PLAINTIFF'S EXHIBIT 181

PRUTTON TABLE VI

Run	Conditions	Gallons of Acid Thru Tubing Between Samples	Samples Taken At Inlet		Samples Taken At Exit		Total Grams Increase Fe in Acid
			Sample No.	ppm Fe	Sample No.	ppm Fe	
2B	Acid directly from stoneware crock through series 2 tubing. 1 gal. per minute at 85° F. Acid was treated with $CuCl_2$, $PbCl_2$, $FeCl_2$.	0	Initial Crock		Initial End	5970	
		25.5			1		
		44			2	2750	
		61.5			3		
		83		2315	4		
	Average Analysis	101.5	Crock 2		5	2770	
	ppm Pb / ppm Cu						
	Inlet 316 / 3.07	122.5			6		
		143			7		
		162			8	2610	
		179.5			9		
		186.3			10		
							299.8

PLAINTIFF'S EXHIBIT 182

PRUTTON TABLE VII

Run	Conditions	Gallons of Acid Thru Tubing Between Samples	Samples Taken At Inlet		Samples Taken At Exit		Total Grams Increase Fe in Acid
			Sample No.	pp m Fe	Sample No.	pp m Fe	
2D	Acid directly from stoneware crock thru series 2 tubing. 1 gal. per min. and 85° F. Acid was treated with $PbCl_2$, $FeCl_2$ and $CuCl_2$.	0	Crock	418	Initial Out	2295	
		25.6			1		
		46.3			2	688	
		62.7			3		
		82.9			4		
		101.9			5	697	
		124.3			6		
		141.3			7		
		163.7			8	669	
		179.3			9		
							195

Average Analysis

	ppm Pb	ppm Cu
Inlet	455	3.71

PLAINTIFF'S EXHIBIT 183

PRUTTON TABLE VIII

Run	Conditions	Gallons of Acid Thru Tubing Between Samples	Samples Taken At Inlet		Samples Taken At Outlet		Total Grams Increase Fe in Acid
			Sample No.	pp m Fe	Sample No.	pp m Fe	
2E	4.465N HCl directly from stoneware crock thru series 2 tubing. 1 gal. per minute and 85° F. Acid was treated with $PbCl_2$, $FeCl_2$, and Cu_2Cl_2.	0	Crock 1		Initial Out		
		23			1		
		45			2	550	
		63.5		382	3		
		80.5			4		
		103.2			5	508	
		120.5	Crock 2		6		
	Average Analysis	142.5			7		
	ppm Pb ppm Cu	165.5			8	433	
	Inlet 340 3.8						
		186.0			9		
		191.5					101.4

PLAINTIFF'S EXHIBIT 184

CORROSION OF OIL WELL TUBING BY 15% HYDROCHLORIC ACID

C. F. Prutton
June 20, 1941

Object

To determine the effect of dissolved iron, lead and copper in reducing the rate of attack of 15% hydrochloric acid upon oil well tubing.

Summary and Conclusions

1. Copper and lead added in low concentrations to 15% hydrochloric acid greatly reduce the rate of attack of the acid upon oil well tubing.

2. In the tests conducted, commercial hydrochloric acid diluted to 15% concentration, attacked the oil well tubing at the rate of from 70 to 80 grams of iron dissolved per square meter of surface per hour of contact or 0.344 to 0.393 pounds per square foot per day. The rate of attack of this same acid, to which was added metals to correspond to the composition of Halliburton truck samples as reported to us by Mr. Rebbeck, showed a rate of attack of only 20 to 30 grams of iron dissolved per square meter of steel surface per hour of contact or 0.098 to 0.147 pounds per square foot per day.

Outline of Work

Mr. J. W. Rebbeck of the Dow Chemical Co. supplied the composition of acid used by Halliburton in acidizing oil wells in Michigan. He reported the acid samples taken from Halliburton truck tanks contained approximately 380 parts per million iron, 340 parts per million lead, and 3.8 parts per million copper.

In this work we have determined the rate of attack of

fifteen per cent hydrochloric acid upon oil well tubing, and the rate of attack of this same acid, to which have been added the amounts of metal Mr. Rebbeck has reported in Halliburton samples.

Laboratory tests to determine the rate of attack of such acids upon oil well tubing were made, using small sections of oil well tubing. Large scale tests were then made, in which a large volume of the acid was flowed through a 112 feet long section of oil well tubing, to approximate conditions occurring in the acidizing of an oil well.

The oil well tubing used for all of these tests was obtained from the Oil Well Supply Co. of Pittsburgh, Penna., and has the following specifications:

1¼" Oil Well Tubing, external upset, range 1, T and C, 2.40 lbs.

Couplings were supplied with the tubing.

Each length of tubing and coupling was given a permanent marking.

To set up the large scale setup an elbow and tee were required. Each was made by welding the threaded ends cut from one length of the oil well tubing.

A. Laboratory Tests

The following procedure was employed to determine in a small scale laboratory test, the rate at which hydrochloric acid dissolved the oil well tubing.

1. Preparation of Tubing Samples:

One length of the 1¼" oil well tubing was employed to prepare samples for the laboratory tests. Sections slightly over one inch in length were cut from this tubing. These samples were then given the following treatments before use in the test.

1. Washed thoroughly with a 50-50 mixture of benzene and acetone to remove oil.
2. Immersed in 15% C. P. Hydrochloric acid for one hour.

3. Rinsed thoroughly in water.
4. Dried in oven at 103° C. for few minutes.
5. Ends of sample faced off in lathe, avoiding oil and handling, to exactly one inch length.
6. Inside and outside sample brushed with clean steel brush.
7. Rinsed thoroughly in acetone.
8. Dried for several minutes at 105° C. in oven.
9. Cooled in desiccator and stored until start of test.

B. Test Procedure:

(a) The acid to be tested was placed in a 2000 cc. wide mouth glass bottle. The volume of acid used was 1360 cubic centimeters. The bottle containing the acid was placed in a constant temperature bath, kept at 30° + or — .05° C., for thirty minutes before starting the test.

(b) A one inch sample of the oil well tubing, which had been prepared as previously described, was accurately weighed. This sample was then suspended on a glass hook in the hydrochloric acid contained in the test bottle. The glass hook was fastened into the plastic top of the test bottle. The sample was maintained in the center of the acid contents of the test bottle, at an angle of 45° from the vertical, by this glass hook.

(c) At the end of exactly three hours, the sample was removed, washed thoroughly with distilled water, then with acetone, dried in the oven at 105° C. for several minutes, cooled in a desiccator and then accurately weighed.

(d) Calculations of Results: Results of this test were expressed in *Grams of Steel Dissolved per Square Meter of Area per Hour of Acid Contact.*

$$\frac{\text{Loss in Weight of Tubing in Grams} \times 10{,}000}{\text{Area of Tubing in Square Centimeters} \times 3} = \text{Grams Steel Dissolved/Meter}^2\text{/Hour}$$

This was converted to "pounds of steel dissolved per square foot of area per day of contact."

(e) The "Per cent Corrosiveness Reduced" was calculated from: Per cent Corrosiveness Reduced=

$$\frac{\text{Grams/M}^2\text{/hr dissolved by chem. pure acid—gm}^2\text{/m}^2\text{/hr dissolved by sample acids x 100}}{\text{gm/m}^2\text{/hr dissolved by C. P. acid}}$$

C. Laboratory Test Results:

Chemically pure hydrochloric acid, obtained from the Grasselli Division of the DuPont Co., was diluted to a concentration of 15% hydrochloric by weight, using distilled water.

Tests were made upon this diluted C. P. acid, and upon the samples of this same acid to which definite amounts of iron, lead and copper chlorides had been added. The various concentrations of iron, lead and copper chlorides used in the different samples tested, covered the range of metal compositions reported to us by Mr. J. W. Rebbeck, as having been found in various samples of acid obtained from Halliburton truck tanks and used in the acidizing of oil wells in Michigan.

Reagent-grade Baker and Adamson ferrous chloride, lead chloride and cupric chloride were used to prepare the acid samples for testing. In each prepared acid solution, the exact content of iron, lead and copper was determined by exact chemical analysis before using the acid in the test.

PLAINTIFF'S EXHIBIT 185

PRUTTON TABLE IX

Run	Conditions	Gallons of Acid Thru Tubing Between Samples	Samples Taken At Inlet		Samples Taken At Outlet		Total Grams Increase Fe in Acid
			Sample No.	ppm Fe	Sample No.	ppm Fe	
1M	Menaul Method Acid and Special tank for 6 hrs. and 33 min. at 85° F. Rate one gal. per min. Series 1 tubing	0	Initial Crock				
		0	Initial Tank	1106	Initial	2130	
		28.5	T-1		1		
		48.5	T-2	1200	2	1570	
	Average Analysis	67.	T-3		3		
	ppm Pb ppm Cu	86.5	T-4		4		
	Inlet 362 4.3						
		106.5	T-5	1340	5	1757	
		123.5	T-6		6		
		143.5	T-7		7		
		163.5	T-8		8	2000	
		182.5	T-9	1590	9		
		198.2	T-10		10		

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PRUTTON TABLE X

Run	Conditions	Gallons of Acid Thru Tubing Between Samples	Samples Taken At Inlet		Samples Taken At Outlet		Total Grams Increase Fe in Acid
			Sample No.	ppm Fe	Sample No.	ppm Fe	
1N	Menaul Method No wire connected. Temperature 85° F. and rate 1 gal. per minute. Acid in special tank for 6¼ hours. Series 1 tubing.	0	Initial Crock	16.7			
		0	Initial Tank		Initial Out	3465	
		28.5	T-1		1		
		48	T-2	1450	2	1830	
		67	T-3		3		
	Average Analysis	84	T-4		4		
	ppm Pb ppm Cu	105	T-5	1672	5	2155	
	Inlet 158 3.25	125	T-6		6		
		142.5	T-7		7		
		160.5	T-8	1830	8	2266	
		181.5	T-9		9		
		187.8			10		

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PRUTTON TABLE XI

Run	Conditions	Gallons of Acid Thru Tubing Between Samples	Samples Taken At Inlet		Samples Taken At Exit		Total Grams Increase Fe in Acid
			Sample No.	ppm Fe	Sample No.	ppm Fe	
2M	Menaul Method. Temperature 85° F. and rate 1 gal. per min. Acid in special tank for seven hours. Series 2 tubing.	0	Crock Tank		Initial		
		0	Initial	1560	Out	3140	
		29	T-1		1		
		48	T-2	1785	2	2130	
	Average Analysis ppm Pb ppm Cu	67	T-3		3		
	Inlet 291 2.88	88	T-4		4		
		108	T-5	2000	5	2370	
		127	T-6		6		
		144.5	T-7		7		
		164	T-8	2285	8	2610	
		184	T-9		9		
		187.75			10		265.5

Plaintiff's Exhibit 185

PRUTTON TABLE XII

Run	Conditions	Gallons of Acid Thru Tubing Between Samples	Samples Taken At Inlet		Samples Taken At Exit		Total Grams Increase Fe in Acid
			Sample No.	ppm Fe	Sample No.	ppm Fe	
2N	Menaul Method Acid in Special Tank for 6 hrs. and 30 min. at 85° F. Rate one gal. per min. Wire Disconnected. Series 2 Tubing	0	Initial Crock				
		0	Initial Tank	680	Initial	323	
		28.8	T-1		1		
		47	T-2	790	2	1022	
		68	T-3		3		
	Average Analysis ppm Pb ppm Cu	88.5	T-4		4		
	Inlet 247 2.32	106	T-5	920	5	1209	
		127	T-6		6		
		144.4	T-7		7		
		163	T-8	1070	8	1320	
		181.5	T-9		9		
		187.8			10		195.7

PLAINTIFF'S EXHIBIT 192

HISTORY OF OIL DEVELOPMENT IN LIMESTONE FORMATIONS PRIOR TO 1932

OHIO

I. First Limestone fields—

Fields	County	Date of Discovery
(a) Lima—Indiana	N.W. Ohio	1885
(b) Newberg	Cuyahoga	Circa—1915

II. Approximate number of limestone fields producing oil or gas prior to 1932, 10.

III. Approximate number of Companies operating in State prior to 1932—no record.

Names of some companies known to have operated in State prior to 1932: Pure Oil Co., Gordon Oil Co., Bell & Scholl, East Ohio Gas Co., Ohio Fuel Supply Co., Sun Oil Co., Ohio Oil Co., Preston Oil Co., Lupher Drilling Co., Stahl Drilling Co., Murry B. Chidester, Carl B. Schwing, Gulf Oil Corporation, Hope Natural Gas Co.

INDIANA

I. First Limestone Fields—

Fields	County	Date of Discovery
(a) Greensburg	Decatur	1893
(b) Riley	Vigo	1906
(c) Shelburn-Graysville	Sullivan	1911
(d) Trenton	Many	1886

II. Approximate Number of Limestone Fields Producing Oil Prior to 1932, 11.

III. Approximate Number of Companies Operating in State Prior to 1932, 4. Names of Companies: Siosi Oil & Gas Co., Big Four Oil & Gas Co., Ohio Oil Co., Scott Oil Co.

KANSAS

I. First Limestone Fields—

Field	County	Date of Discovery
(a) Lyons	Rice	1888
(b) Vernon (north)	Sumner	1915
(c) Augusta (north)	Butler	1914
(d) Eldorado	Butler	1917
(e) Winfield	Cowley	1914
(f) Dexter	Cowley	1903
(g) Fairport	Russell	1923

II. Approximate number of Limestone Fields Producing Oil or Gas Prior to 1932, 78.

III. Approximate Number of Companies Operating in State Prior to 1932, 48. Names of Companies: Superior Oil Co., Skelley, Slick Pryor & Lockhart, Magnolia, Sinclair, Empire Oil & Refining, Ohio Oil Co., National Refining Co., Phillips Petroleum Co., Cox & Mcginnis, Stanolind Oil & Gas Co., Deep Rock, Texas, Pure Oil Co., Alf M. Landon, Continental, I. T. I. O., Lew Wentz Oil Corp., Shell Oil Co., Gulf Oil Corp., Amerada Petroleum Co., Barnsdall Oil Co., Dickey Oil Co., Gled Oil & Gas Co., Hartman & Blair, Houston Oil Co., Olsen Oil Co., Wilcox Oil & Gas Co., Derby Oil Co., Lario Oil & Gas Co., Ramsey et al., Plains Oil Co., Noble Oil Co., Central Petroleum Co., Twin Drilling Co., J. C. Shaffer, Transwestern Oil Co., Smokey Hill Oil Co., Maybee Consolidated Oil Corp., Vickers Petroleum Co., Champlin Refining Co., British American Oil Producing Co., Tom Palmer, Sunray Oil Co., Barbara Oil Co., Watchorn Oil Co., Helmerich & Payne Inc., T. M. Deal.

MICHIGAN

I. First Limestone Fields—

Field	County	Date of Discovery
(a) Port Huron	St. Clair	1898
(b) Hart	Oceana	1932
(c) Leaton	Isabella	1929
(d) Muskegon	Muskegon	1927
(e) Mt. Pleasant	Midland-Isabella	1928
(f) Porter	Midland	1931

II. Approximate Number of Limestone Fields Producing Oil or Gas Prior to 1932, 8.

III. Approximate Number of Companies Operating in the State Prior to 1932, 10. Names of Companies: Pure Oil Co., Stanolind Oil & Gas Co., Ohio Producing & Refining Co., Johnson Oil & Refining Co., Wittmer Oil & Gas Co., Nollem Oil & Gas Co., Chartiers Oil Co., Sun Oil Co., Bell Oil & Gas Co., Gordon Oil Co.

OKLAHOMA

I. First Limestone Fields—

Field	County	Date of Discovery
(a) Cleveland	Pawnee	1904
(b) Jennings	Pawnee	1916
(c) Yale-Quay	Payne	1914
(d) Boynton	Muskogee	1914
(e) Henrietta	Okmulgee	1910
(f) Bixby	Tulsa	1916
(g) Broken Arrow	Tulsa	1901
(h) Jenks	Tulsa	1901
(i) Bristow	Creek	1916
(j) Cushing	Creek	1912
(k) Braman	Kay	1924
(l) Oklahoma City	Oklahoma	1928
(m) Barnsdall	Osage	1916
(n) Drumright	Creek	1912
(o) Wetumka	Hughes	1923

II. Approximate number of limestone fields producing oil or gas prior to 1932, 109.

III. Approximate number of companies operating in State prior to 1932, 28. Names of Companies: Pure Oil Co., Shell Oil Co., Gulf Oil Co., Mid-Continent Oil Co., Magnolia Petroleum Co., Amerada Petroleum Co., Skelly Oil Co., Barnsdall Oil Co., Sun Oil Co., Ohio Oil Co., Atlantic Oil Refg. Co., Carter Oil Co., Stanolind Oil & Gas Co., Sinclair Prairie Oil Co., Tidewater Associated Oil Co., Deep Rock Oil Co., Phillips Petroleum Co., Continental Oil Co., Champlin Oil & Refg. Co., Cities Service Oil Co., I. T. I. O. Co., Sunray Oil Co., British American Oil Producing Co., Denver Producing & Refg. Co., Bay Oil Co., Alf M. Landon, Darby Pet. Co., Gypsy Oil Co., Superior Oil Co.

TEXAS

I. First Limestone Fields—

Field	County	Date of Discovery
	District—West Texas	
(a) Gulf-McElroy	Crane, Upton	1926
(b) Sand Hills	Crane	1930
(c) World-Powell	Crockett	1926
(d) Iatan-Denman	Howard	1925
(e) Westbrook	Mitchell	1921
(f) Big Lake	Reagan	1923
(g) McCamey	Upton-Crane	1925
	District—East Central Texas	
(h) Bosque	McClennan	1902
(i) Panola	Panola	1921
(j) Waskom	Harrison	1924
	District—North Central Texas	
(k) Ranger	Eastland	1918
(l) Breckenridge	Stephens	1916
(m) Noodle Creek	Jones	1926

	District—Panhandle of Texas	
(n) Carson	Carson	1921
(o) Hutchinson	Hutchinson	1922
(p) Moore	Moore	1926
(q) Potter	Potter	1919
	District—South Texas	
(r) Luling	Coldwell-Guadalupe	1921
(s) Salt Flats	Coldwell	1928
(t) Dale	Coldwell	1927
(u) Darst Creek	Guadalupe	1928

II. Approximate number of limestone fields producing oil or gas prior to 1932.

District	Number
(a) West Texas	22
(b) East Central Texas	6
(c) North Central Texas	10
(d) South Central Texas	9
(e) Panhandle of Texas	7
Total	54

III. Approximate number of Companies operating in State prior to 1932.

District	Number
West Texas	50
East Central Texas	5
North Central Texas	17
South Central Texas	39
Panhandle of Texas	23
Total	134

Names of Companies

District—West Texas

Gulf, Humble, Tidewater, Magnolia, Sinclair-Prairie, Phillips, Texas Co., Shell Oil Co., Cities Service Oil Co., Barnsdall Oil Co., Stanolind Oil and Gas Co.

District—East Central Texas

United Gas Co., Texas Co., Natural Gas Production Co., Arkansas Fuel Oil Co., D. Thompson Drilling Co., Nick Babare.

District—North Central Texas

Magnolia, Lone Star Gas Co., Gulf Oil Corp., Sinclair Prairie, Texas Co., Humble Oil and Refg., Shell Oil Co., Phillips Petroleum Co.

District—South Central Texas

Sun Oil Co., Philtop Oil and Gas Co., McAlester Fuel Co., Magnolia Pet. Co., Rio Bravo Oil Co., Gulf Oil Corp., Empire Oil & Gas Co., Cities Service Oil Co., Texas Co., Forest Development Co.

District—Panhandle of Texas

Barnsdall Oil Co., British American Oil Prod. Co., Cities Service Oil Co., Gulf Oil Corp., Phillips Pet. Co., Pure Oil Company, Ohio Oil Co., Northern Natural Gas Co., Panhandle Eastern Gas Co., Magnolia Pet Co., Continental Oil Co., Stanolind Oil & Gas Co., Skelly Oil Co., Sinclair Prairie Oil Co.

KENTUCKY

I. First Limestone Fields—

Field	County	Date of Discovery
(a) Big Sinking	Lee, Estell	1917
(b) Irvine	Estell, Powell	1915
(c) Campton	Wolf	1903
(d) Bowling Green	Warren, Allen	1918

II. Approximate number of limestone fields producing oil and gas prior to 1932, 8.

III. Approximate number of companies operating in state prior to 1932, 7. Names of Companies: Texas Co., South Penn. Oil Co., Gulf Oil Co., Evans Oil & Gas Co., Petroleum Exporation Co., Johnson Oil & Gas Co., Snowden & McSweeney Inc.

ILLINOIS

I. First Limestone Fields—

Field	County	Date of Discovery
(a) Westfield	Clark	1904
(b) Martinsville	Clark	1907
(c) Main (several pools)	Crawford	
(d) Lawrence	Lawrence & Crawford	1906

II. Approximate Number of Limestone Fields Producing Oil or Gas Prior to 1932, 8.

III. Approximate Number of Companies Operating in State Prior to 1932, 10. Names of Companies: Tidewater Oil & Gas Co., Ohio Oil Co., W. C. McBride Inc., Kewanee Oil & Gas Co., Bell Bros., Mahutska Oil Co., Big Four Oil & Gas Co., Hamilton Oil & Gas Co., American Oil & Gas Dev. Co., Craig & Lowery.

NORTH LOUISIANA

I. First Limestone Fields—

Field	County	Date of Discovery
(a) Bethany-Waskom	Caddo	1916
(b) Caddo	Caddo	1904
(c) Monroe	Union, Morehouse Ouachita	1916
(d) Rodessa	Caddo	1930
(e) Swalle	Sabine	1928
(f) Pine Island	Caddo	1906
(g) Sligo	Bossier	1922

II. Approximate number of limestone fields producing oil and gas prior to 1932, 12.

III. Approximate number of companies operating in state prior to 1932, 10. Names of Companies: Union Producing Co., United Carbon Co., Southern Carbon Co., The Hunter Co., Magnolia Petroleum Co., Ohio Oil Co., Texas Co., Standard Oil Co. of Louisiana, Stanolind Oil & Gas Co., Arkansas Fuel Oil Co.

WYOMING

I. First Limestone Fields—

Field	County	Date of Discovery
(a) Black Mt.	Hot Springs	1925
(b) Byron	Big Horn	1932
(c) Garland	Big Horn-Park	1927
(d) Hamilton Dome	Hot Springs	1918
(e) Warm Springs	Hot Springs	1917
(f) Oregon Basin	Park	1926
(g) Lander	Fremont	1914

II. Approximate number of limestone fields producing oil or gas prior to 1932, 15.

III. Approximate number of companies operating in State prior to 1932, 18. Names of Companies: Ohio Oil Co., Continental Oil Co., Midwest Refg. Co., Texas Co., Sinclair-Wyoming Oil Co., Atlantic & Pacific Oil Co., Stock Oil Co., Argo Oil Co., Empire State Oil Co., Kinney Coastal Oil Co., Utah Refining Co.

MONTANA

I. First Limestone Fields—

Field	County	Date of Discovery
(a) Kevin Sunburst	Toole	1922
(b) Pondera	Teton	1927

II. Number of Limestone fields producing oil or gas prior to 1932, 2.

III. Approximate number of Companies operating in State prior to 1932, 11. Names of Companies: California Co., Continental Oil Co., Texas Co., Texas Pacific Coal & Oil Co., Ohio Oil Co., W. E. Rice, Stanolind Oil & Gas Co., Triangle Oil & Gas Co., Boris A. S. Aranow, 56 Petroleum Co., Homestake Oil Co.

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NEW MEXICO

I. First Limestone Fields—

Field	County	Date of Discovery
(a) Artesia	Eddy	1923
(b) Eunice	Lea	1928
(c) Hobbs	Lea	1928
(d) Jal	Lea	1927
(e) Maljamar	Lea	1926

II. Approximate number of Limestone fields producing oil or gas prior to 1932, 9.

III. Approximate number of companies operating in State prior to 1932, 25. Names of Companies: Maljamar Oil Co., Repollo Oil Co., Stanolind Oil & Gas Co., Texas Co., Empire Oil & Refining Co., Continental Oil Co., Tidewater Oil Co., Humble Oil & Refining Co., Gulf Oil Co., Phillips Petroleum Co., Amerada Petroleum Co., Skelly Oil Co., Shell Oil Co., Ohio Oil Co., Atlantic Refining Co., Sun Oil Co.

HISTORY OF ACIDIZING

In Fields Discovered Prior to 1932

State	Company	Approximate Number of Treatments
Illinois		
	W. C. McBride	29
	Big Four Oil & Gas Co.	10
	Ohio Oil Co.	10
	Miscellaneous	50
Indiana		
	Big Four Oil & Gas Co.	4
	Siose Oil Co.	1
	Chas. Parriott	5
	See Oil Co.	5
	Miscellaneous	16

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State	Company	Approximate Number of Treatments	
		Eastern Kansas	Western Kansas
Kansas			
	Skelly	37	97
	Stanolind	7	308
	I. T. I. O.		25
	Continental Oil	7	5
	Phillips	16	121
	W. C. McBride		69
	Darby Petroleum Co.		23
	Twin Drilling Co.		4
	Cities Service Oil Co.	117	121
	Bay Petroleum Co.		3
	Lario Oil & Gas Co.	1	8
	Atlantic Refg. Co.		6
	Spencer-Yarnell	5	
	Texas Co.	2	157
	Derby Oil Co.	1	15
	Sinclair Prairie	79	520
	Gulf Oil Co.	2	61
	T. C. Johnson	2	29
	Shell Oil Co.		201
	Wilcox Petroleum Co.	10	31
	Carter Oil Co.		11
	Coralena Oil Co.		
	Central Petroleum Co.	7	67
	Bridgeport Machine		20
	Alva Billings		16
	Barbara Oil Co.	10	2
	Vickers Pet Co.	12	5
	Kanoko Oil & Gas Co.		8
	Olson Oil Co.		28
	Westgate Greenland		3
	Tom Palmer		12
	Pryor & Lockart	2	12
	Transwestern		12

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State	Company	Approximate Number of Treatments	
	J. E. Mabee		45
	Meade Prod. Co.		10
	Aikman & Braden	7	13
	British American		1
	O.K.O. Oil & Gas Co.		13
	Adair Morton	22	
	Red & Morris	2	
	W. O. James	11	
	Cox & McGinnis	6	
	Pure Oil Co.	21	
	Superior Oil Co.	4	
	Amerada Pet Co.	6	
	Jayhawk Oil Co.	19	
	Shull Drg. Co.	16	
	Woodson Pipe Line Co.	10	
	Sagamore Oil & Gas Co.	32	
	Alf. M. Landon	4	
	Barnsdall		27
	J. C. Shaffer		23
	Continental Oil Co.		30
	Bishop Oil Co.		2
	J. J. Hall		8
	Ohio Oil Co.		2
Kentucky			
	Texas Co.		10
	South Penn		11
	Petroleum Exploration		6
	Evans Oil & Gas		3
	Miscellaneous		93
Louisana			
	Union Prod. Co.		320
	Southern Carbon Co.		126
	Interstate Natural Gas		72
	United Carbon Co.		29

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State	Company	Approximate Number of Treatments
	D. Thompson Drg. Co.	17
	Hunter Co.	55
	Magnolia	11
	Crescent Drg. Co.	14
	Ohio Oil Co.	5
	Stanolind	58
	Texas Co.	35
	Magnolia	34
	Miscellaneous	543
Michigan		
	Pure Oil Co.	60
	Stanolind	5
	Wittmer Oil & Gas	27
	Chartiers Oil Co.	23
	Miscellaneous	648
New Mexico		
	Maljamar Oil Co.	23
	Barnsdall	4
	Sinclair	6
	Skelly	1
	Repello	33
	Stanolind	10
	Texas	27
	Empire Oil & Refg. Co.	8
	Continental	27
	Tidewater	10
	Humble Oil & Gas Co.	8
	Phillips	34
	Stanolind	39
	Amerada	26
	Gulf	2
	Shell Oil Co.	23
	Skelly Oil Co.	1
	Ohio Oil Co.	9
	Miscellaneous	32

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State	Company	Approximate Number of Treatments
Oklahoma		
	Pure Oil Co.	70
	Shell Oil Co.	28
	Skelly Oil Co.	26
	Gulf Oil Corp.	42
	Magnolia Oil Co.	11
	Sinclair Prairie	286
	Texas Co.	37
	Mid-Continent	26
	Atlantic Refining Co.	47
	Carter Oil Co.	199
	Tidewater Oil Co.	13
	Ohio Oil Co.	0
	Phillips Petroleum Co.	51
	Deep Rock Oil Co.	15
	Barnsdall Oil Co.	5
	Amerada Oil Co.	27
	Cities Service Oil Co.	81
	Continental Oil Co.	19
	Stanolind Oil & Gas	63
	I. T. I. O.	60
	Champlin Refining Co.	11
	Denver Producing & Refining	152
	Sun Oil Co.	2
	Darby Oil Co.	27
	Sunray	9
	British American	11
	Miscellaneous	1028
Ohio		
	Marxer & Lung	20
	Murry B. Chidester	25
	Ohio Oil Co.	10
	Wehrle Bros.	18
	J. L. Morrisey	6
	Wiser Oil Co.	3
	Miscellaneous	73

Plaintiff's Exhibit 192

State	Company	Approximate Number of Treatments
Texas (west)		
	Gulf Oil Corp.	82
	Humble Oil & Refining Co.	65
	Tidewater	9
	Cities Service Oil	1
	Sinclair-Prairie	39
	Texas Co.	35
	Phillips Petroleum Co.	2
	American Liberty Oil	11
	Barnsdall Oil Co.	3
	Standard Oil Co. of Texas	48
	Skelly Oil Co.	20
	Laudreth Petroleum Co.	40
	Stanolind Oil & Gas Co.	50
	Continental	65
	Atlantic Refining Co.	47
	Shell Oil Co.	93
	Sun Oil Co.	6
	Amerada Petroleum Co.	21
	Pure Oil Co.	16
	Mid-Kansas (Ohio Oil Co.)	13
	Texas, Pacific Coal & Oil Co.	10
	Big Lake Oil Co.	41
	Miscellaneous	226
Texas (North Central)		
	Lone Star	10
	Sinclair Prairie	18
	Shell	3
	Continental	38
	Miscellaneous	35
Texas (Panhandle)		
	Barnsdall	6
	British American	1
	Cities Service	22
	Gulf Oil Corp.	13

Plaintiff's Exhibit 192

State	Company	Approximate Number of Treatments
	Humble Oil & Refining Co.	4
	I. T. I. O.	5
	Magnolia	21
	Ohio Oil Co.	2
	Panhandle Eastern	20
	Phillips	99
	Pure Oil Co.	1
	Continental	30
	Texas Co.	12
	Shell	27
	Sinclair-Prairie	16
	Shamrock Oil Co.	43
	Skelly Oil Co.	20
	Sun Oil Co.	2
	Stanolind	25
	Miscellaneous	48
South Texas		
	Sun Oil Co.	1
	McAlester Fuel Co.	4
	Rio Bravo Oil Co.	2
	R. E. Fair	2
	Magnolia Petroleum Co.	62
	Forest Development Co.	7
	Felmont Corp.	5
	Trio Oil Co.	16
	Miscellaneous	55
Montana		
	Aranon	16
	W. E. Rice	61
	Lon Crumley	18
	New Era Fuel Co.	10
	Wm. Fulton	10
	D. S. Kelley	8
	Stanolind	39
	Texas	19
	Miscellaneous	168

State	Company	Approximate Number of Treatments
Wyoming		
	Ohio Oil Co.	12
	Yale Petroleum Co.	12
	Stock Oil Co.	20
	Argo Oil Co.	6
	Miscellaneous	30

PLAINTIFF'S EXHIBIT 195

(Montana Oil and Mining Journal, Jan. 26, 1935)

PONDERA PRODUCTION UP 22,000 BARRELS

Use of Acid Boosts Field Production Total 3,675,391 Bbls.

With no new drilling, Pondera oil field increased its production during 1934 by 22,210 barrels over 1933, according to official production figures compiled in the office of the Petroleum Conservation Board.

This increase in production was due to the use of acid on the lime formation in these wells, chiefly during the latter part of the year.

The 1934 production brings the total yield of the field up to 3,673,391.74, which has been marketed for slightly more than three millions of dollars.

The 1933 production, totaling 338,189 barrels, sold for $227,749.80.

The 1934 production, totaling 360,399.91 barrels, sold for $450,499.89.

The tremendous gain for the producers is due to the fact that during the entire year of 1934 the oil sold for $1.25 per barrel, whereas in 1933 oil sold for 60 cents per barrel up to June 17 and thereafter for 75 cents during the balance of the year.

The average production per well in Pondera field is in excess of $20,000. The average per acre yield of the field to date is approximately $4,000.

The drilling of not less than 12 and perhaps as many as 20 wells is expected in this field during the coming year, chiefly to the north and northwest of present production. The other limits of the field are defined.

Following is the total production by years and the production by months for the year 1934:

1928	175,000.00
1929	1,007,782.70
1930	757,207.49
1931	559,266.22
1932	477,546.12
1933	338,189.30
1934	360,399.91
Total	3,675,391.74

	1934
January	28,849.13
February	24,033.51
March	27,852.53
April.	26,484.03
May	26,799.07
June	25,603.85
July.	26,646.09
August	27,313.12
September	29,324.03
October.	38,647.13
November.	39,257.50
December	39,589.92
Total	360,399.91

PLAINTIFF'S EXHIBIT 218-A

Old Dixie Pump P. D.

Mumy #2; 6-22-1932; 6 carboys used; Put in with Bailer; 80 bls. oil used; 200 lbs. P.

Mumy #3; 6-29-1932; 18 carboys used; dumped in; 85 bls. oil used; 300 lbs. Pressure.

PLAINTIFF'S EXHIBIT 218-B

Old Dixie pump 200 bb. 24 hrs.

Acid used Hastings #1; 7-24-1932; 1,000 gal.; Casing Head 500 lbs.; tubing 250 to 300; Wells F. Malcom.

Struble #1; 1,000 gal.; Casing Head No Pressure; tubing Vacuum; 7-26-1932; McAllahan Oil Co.; 367 bb. 24 hrs.

Coon #1; 1000 Gal.; Casing Head 100 to 300; tubing 30 to 100; Stork Oil Co.; 7-27-1932; 80 bls. 10 hrs.

Root #1; 1000 gal.; Tube Pressure None; casing; Packer 2"; 7-30-1932.

8-1-1932; Cole # 1; J. C. Arthurs; 1000 gal. Dixie Pump; No oil used; No Pressure; Poor connections.

8-2-1932; Morrison #2; W. L. McAllahan; 1000 gal. Dixie Pump; Very little pressure; 80 bls. oil used.

8-6-1932; Hastings #1 Dixie P.; Second time—1000 gal.; Pressure tub. 50; Oil used—none.

8-5-1932; Stork Oil Co.; Coon #4; 1000 gal.; Pressure none; Oil used 60 bls.; Dixie pump.

8-7-1932; G-Lee-P Oil Co. 1000; Schaffer #1; Pressure —; Oil used 7"; Dixie pump.

PLAINTIFF'S EXHIBIT 218-C

8-8-1932; Columbia Oil Gas Co.; Rornick #3; 500 Gal.; No Pressure; Simarall Pump.

8-9-1932; McAllahan; Schaffer #1; 1000 gal.; 450 Pressure tubing; 900 Pressure casing head; Simarall Pump.

8-11-1932
Two Well 500 each
Witt-Nelson
Muskegon
No pressure
Dixie Pump
} 2 well

8-15-1932; Michigan Oil Gas Co.; 1000 gal.; Mudding machine pump.

8-16-1932; Columbia Oil Gas; 2 well 500 gal. Each; Simarall Pump; Arthur's Truck.

Parafine Walting chemical; Carbon Bisulphide (Dow).

8-18-1932; Columbia Oil Gas; 1000 gal.; 300 Pressure; Mudding machine.

8-24-1932; Talbot Oil Co.; Adams #1; 500 gal.; No Pressure.

8-24-1932; Jones Oil Co. Voorhies; Jones #1; 500 gal.

8-26-1932; Shuller, Voorhies, Wilson, Strange; Well #1; Reimenschneider; 1300 gal.; 150 to 300 pressure.

8-28-1932; Struble #2; McCallahan; 1000 gal.; 800 lbs. Pressure; 75 bls. oil.

PLAINTIFF'S EXHIBIT 218-D

8-28-1932; Gordon Oil Gas Co.; Columbia Oil Gas Co.; Tanker #1; 1000 gal.

9-1-1932; Schaffer #1; McAllahan; 1000 gal.; 300 P. Casing Head—tub. 50 lbs.; 123 bls. Oil Used.

9-6-1932; Stork Oil Co.; No. P. Pump no good; 500 gal.

9-11-1932; G-Lee-P Schaffer #1; 500 gal.; No. P.

9-12-1932; Talbot; 500 gal.;

9-12-1932; Columbia-Gordon; 1000 Gal.

PLAINTIFF'S EXHIBIT 231-A

THE DOW CHEMICAL COMPANY
Midland, Michigan

Dept. Chlorbenzol Date 2-9-32 Order No. 38118
Ship to: Pure Oil Co.,
Mt. Pleasant Oil Field
Route: To be called for by Pure Oil Co. Truck 2/11
Date shipped: Feb. 11, 1932

	Price
1 Wagon Load Hydrochloric acid (Strong)	NC

PLAINTIFF'S EXHIBIT 231-B

THE DOW CHEMICAL COMPANY
Midland, Michigan, U. S. A.

Folio 3537
Dept. Hydrochloric Acid (Don Hall) Date 3-9-32 Order No. 40327
Invoice to: Same
35 E. Wacker Drive
Chicago, Ill.
Date to be shipped: Will call for 3-10-32
Ship to Pure Oil Co.,
Oil Field
Route: Pure Oil will call for
Date Shipped: Mar. 11, 1932.
Special Instructions to Traffic and Shipping Clerk
Pure Oil will call for 3/10-32

	Price	Amount
500 Gallons Approx 10° Be Hydrochloric Acid 4500# = $14.00 per ton Basis 18° Acid 2500 @ 14.00		
as 18°	per ton	$17.50
To be loaded in tank wagon Plus handling charges		4.68
See R. L. C.		22.18

PLAINTIFF'S EXHIBIT 231-C

THE DOW CHEMICAL COMPANY
Midland, Michigan, U. S. A.

Folio 4516

Dept. Don Hall Date 4-4-32 Order No. 42252
Invoice to: Same
35 E. Wacker Drive
Chicago, Ill.
Date to be shipped: Do not ship
Ship to: Pure Oil Co.,
Oil Field
Date Shipped Apr. 5, 1932
Route Called for Customers Truck

	Price	Amount
500 Gals. Approx. 10° Be Hydrochloric Acid 2500	$14.00 per ton Basis 18 acid	$17.50
Plus 2 portions arsenic acid — Total 6.38.....		6.38
Labor Tank Service—Transfer chg. " 5.80.....		5.80
		29.68

PLAINTIFF'S EXHIBIT 231-D

THE DOW CHEMICAL COMPANY
Midland, Michigan, U. S. A.

Folio 5977

Dept. Benzol Date 4-26-32 Order No. 44094
Invoice to: Same
Date to be shipped Will call 4/27
Customer's Order No. 4/20/32
Date Shipped May 3, 1932
Ship to Pure Oil Producing Co.,
Mt. Pleasant, Mich.
Route: Will call with their truck
Special instructions to traffic and shipping clerk
Truck to stop at 65 bldg. to have arsenic acid placed in tank

	Price	Amount
1 tank load 500 gal. Dow hydrochloric acid (approx 10 Be)	14.00 Ton Basis 18 acid	$17.50
Plus 1 portion arsenic acid Total		3.19
Labor—tank service—transfer chg. total		4.00
		$24.69

PLAINTIFF'S EXHIBIT 231-E

THE DOW CHEMICAL COMPANY
Midland, Michigan, U. S. A.

Folio 6121

Dept. Don Hall Date 5-5-32 Order No. 44793
Invoice to: Same
Date to be shipped: Will Call 5-5-32
Date Shipped May 5, 1932
Ship to: The Pure Oil Producing Co.,
Mt. Pleasant, Mich.
Route: Will call with their truck

	Price	Amount
1 tank load (500 gal.) Dow hydrochloric acid	14.00 per ton	$17.50
(Approx 10 degrees Be)	3.19 Total	3.19
1 portion arsenic acid Labor—Tank Service—Transfer Chg.	4.00 Total	4.00
		$24.69

PLAINTIFF'S EXHIBIT 231-F

THE DOW CHEMICAL COMPANY
Midland, Michigan

Folio 7105

Dept. Don Hall Date 5-20-32 Order No. 46068
Invoice to: Same
Date to be Shipped Will call 5/20
Ship to: Pure Oil Producing Co.,
Mt. Pleasant, Mich.
Date Shipped May 21, 1932
Route: Will call with their truck

	Price	Amount
Tank load (500 gal.) Dow hydrochloric acid (Approx 10 Be)	$14.00	$17.50
1 portion arsenic acid	3.19 Total	3.19
Labor—tank service—transfer chg.	4.00 Total	4.00
		$24.69

PLAINTIFF'S EXHIBIT 231-G

THE DOW CHEMICAL COMPANY
Midland, Michigan, U. S. A.

Folio 7323

Dept. Don Hall Date 5-24-32 Order No. 46377
Invoice To: Same
Date to be shipped: Will call 5/25
Ship to: Pure Oil Producing Co.,
Mt. Pleasant, Mich.
Date Shipped: May 25, 1932
Route: Will call with truck

	Price		Amount
Tank load (500 Gal.) Dow hydrochloric acid (Approx 10 Be)	14.00		$17.50
1 Portion Arsenic Acid	3.19	Total	3.19
Labor—Tank service—transfer chg.	4.00	Total	4.00
			$24.69

PLAINTIFF'S EXHIBIT 231-H

THE DOW CHEMICAL COMPANY
Midland, Michigan, U. S. A.

Folio 7481

Dept. Don Hall Date 5-26-32 Order No. 46,567
Invoice to: Same
Date to be shipped: May 27
Ship to Pure Oil Producing Co., Customer's Order No.
Mt. Pleasant, Mich. Phone 5/26/32 R. F. S.
Date Shipped: May 27, 1932.
Route: Will call with truck

	Price	Amount
Tank load (500 gal.) Dow hydrochloric acid Approx 10 Be	$14.00	$17.50
1 portion arsenic acid	3.19 Total	3.19
Labor,—tank service,—transfer chg.	4.00 Total	4.00
		$24.69

PLAINTIFF'S EXHIBIT 231-I

THE DOW CHEMICAL COMPANY
Midland, Michigan, U. S. A.

Folio 7542

Dept. Don Hall Date 5-26-32 Order No. 46568
Invoice to: Same
Date to be shipped May 28
Customer's Order No. Phone 5/26/32
Ship to: Pure Oil Producing Co.,
Mt. Pleasant, Michigan.
Route: Will call with truck
Date shipped: May 28, 1932

	Price		Amount
Tank carload (500 Gal.) Dow hydrochloric acid—Approx. 10 Be	$14.00		$17.50
1 portion arsenic acid	3.19	Total	3.19
Labor—Tank service—transfer chrgs.	4.00	Total	4.00
			$24.69

PLAINTIFF'S EXHIBIT 231-J

THE DOW CHEMICAL COMPANY
Midland, Michigan, U. S. A.

Dept.: Don Hall Date 5-31-32 Folio 7625
Invoice to: Same Order No. 46763
Date to be shipped May 31
Ship to: Pure Oil Producing Co.,
Mt. Pleasant, Mich.
Date Shipped May 31, 1932.
Route: Will call with truck

	Price		Amount
Tank load (500 Gal.) Dow Hydrochloric Acid (Approx 10 Be)	14.00		$17.50
1 portion arsenic acid	3.19	Total	3.19
Labor—Tank service—Transfer chg.	4.00	Total	4.00
			$24.69

PLAINTIFF'S EXHIBIT 232

DOWELL INCORPORATED
Well Treatments

	1932	1933	1934	1935	1936	1937	1938	1939	1940	Total
Total Treatments	59	1,121	1,988	2,144	3,057	4,764	3,850	4,241	5,522	26,746
Deductions:										
California Treatments	0	0	0	0	2	32	91	48	42	215
Houston District—										
Mud Acid Treatments	0	0	0	0	0	0	3	93	241	337
Dow Chemical Treatments	0	2	0	0	3	5	7	3	21	41
Truck Rentals	0	0	0	1	25	34	51	88	148	347
Stuck Drill Pipe	0	0	4	20	31	23	6	21	28	133
Packer Treatments	0	0	0	0	2	4	18	8	1	33
Total Deductions	0	2	4	21	63	98	176	261	481	1,106
Net Total	59	1,119	1,984	2,123	2,994	4,666	3,674	3,980	5,041	25,640

PLAINTIFF'S EXHIBIT 233

TREATMENTS MADE BY LICENSEES OTHER THAN DOWELL

This report does not include treatments made by California licensees.

	1934	1935	1936	1937	1938	1939	1940
January	0	0	15	27	43	37	29
February	0	14	15	23	26	38	23
March	0	0	17	35	25	50	33
April	0	2	19	52	39	66	59
May	0	11	15	31	32	64	53
June	0	1	32	44	27	57	47
July	0	13	23	39	39	58	34
August	3	17	23	36	39	53	50
September	8	3	21	40	27	49	36
October	13	0	23	42	37	55	31
November	14	1	17	27	45	58	27
December	0	14	36	24	27	50	24
	38	76	256	420	406	635	446

Total—2,277

PLAINTIFF'S EXHIBIT 246

Plaintiff's Exhibit 246

Shipment Record

Product Hydrochloric Acid

Month of Jan., 1932

No.	Date	Order No.	Consignee	No.	Size	Grade	Net Wt.
1	1-23	28590	Ford Motor Co., Detroit, Mich.	Dow X	R8332	18° B.	
			Gross wt. 103,500				
			44,100				
			59,400				
			27.9%				16,550

Month of Feb., 1932

No.	Date	Order No.	Consignee	No.	Size	Grade	Net Wt.
1	2- 2	34614	Cincinnati Chem. Works, St. Bernard, Ohio.	GATX	1765	61750 Gross	20,450
2	2-11	38118	Pure Oil Co., Mt. Pleasant Oil Field	1	Wagon	15% HCl	790
3	2-17	38660	Kleen-Kwik Chem. Co., Flint, Mich.	15 bbls.		19.7 B 30.9%	2,416
4	2-19	36530	Cincinnati Chem. Wks., Norwood, Ohio	Dow X	R8332	31.8%	24,104
5	2-22	38779	Kleen-Kwik Chem. Co., Flint, Mich.	15 bbls.		32.38%	2,596
6	2-24	39143	" " "	15 bbls.		31.5%	2,463
7	2-26	39057	Cincinnati Chem. Works, Norwood, Ohio.	GATX	1765	20B 32.03%	23,734
							76,553

2 Gal. Arsenic Pure Oil (notation below)

Month of March, 1932

No.	Date	Order No.	Consignee	No.	Size	Grade	Net Wt.
1	3- 4	39259	Kleen-Kwik Chem. Co., Flint, Mich.	15	Bbls.	7750# 31.5	2,441
2	3-11	40327	Pure Oil Co., Oil Field	5000# of		15%	750
3	3-16	40560	The Sherwin Williams Co., Kensington, Ill.	GATX	1767	18° B.	19,250
4	3-16	40062	Kleen Kwik Chem. Co., Flint, Mich.	15 Bbls.		7880 32%	2,521
5	3-19	41039	General Dry Batteries, Cleveland, Ohio.	GATX	1765	18°	16,800
6	3-31	40774	Cincinnati Chem. Works, Norwood, Ohio	GATX	1768	20° B.	24,500
							66,262

March HCl sales

	1767	1768
HCl ad.	68800	76100
%	27.98	32.2

2 gal. Arsenic Pure Oil (notation below)

Month of April, 1932

No.	Date	Order No.	Consignee	No.	Size	Grade	Net Wt.
1	4- 2	41832	Ford Motor Co., Detroit, Mich.	Dow X	R8332	18° B.	17,615
2	4- 5	42252	Pure Oil Co., Oil Field	1 Tank W		68 cu. ft. 15% HCl	750

			St. Bernard, Ohio				
4	4-27	44094	Pure Oil Co.,			68 cu. ft.	
			Mt. Pleasant, Mich.	1 Tank W		15%	750
5	4-29	44298	Peebles Chem. Co., Wash., D. C.	1 Bottle		20° B.	
			Dow X R8332 61,700 18				
			GATX 1765 74,500 20				43,101
			4 gal. Arsenic Acid Pure Oil (notation below)				
			St. Bernard, Ohio	GATX	1765		23,400

Month of May, 1932

No.	Date	Order No.	Consignee	No.	Size	Grade	Net Wt.
1	5- 4	44568	Sherwin & Williams, Kensington, Ill.	Dow X	R8332	18° B.	14,850
2	5- 5	44793	Pure Oil Co., Mt. Pleasant, Mich.	Trailer tank		15%	750#
3	5- 6	42937	Cincinnati Chem. Wks., Norwood, Ohio	GATX	1768	20° B.	24,100
4	5-10	45227	General Dry Batteries, Cleveland, Ohio	GATX	1767	18° B.	17,520
5	5-16	45057	Ford Motor Co., Detroit, Mich.	GATX	1766	18° B.	16,700
6	5-21	46068	Pure Oil Co., Mt. Pleasant, Mich.	Trailer Tank		15%	750
7	5-25	46377	Pure Oil Co., Mt. Pleasant, Mich.	Trailer Tank		15%	750
8	5-27	46567	" " "	Trailer Tank		15%	750
9	5-28	46568	Pure Oil Producing Co., Mt. Pleasant, Mich.	Trailer Tank		15%	750
10	5-31	46763	Pure Oil Producing Co., Mt. Pleasant, Mich.	Trailer Tank		15%	750
			8332 53400 27.92				
			1768 73600 32.75				
			1767 62400 28.09				
			1766 56500 29.48				
			12 gal. Arsenic Pure Oil (notation below)				77,670

Month of June, 1932

No.	Date	Order No.	Consignee	No.	Size	Grade	Net Wt.
1	6- 1	46,904	Columbia Oil & Gas Co., Mt. Pleasant, Mich.	6	cby.	15%	80
2	6- 3	47,081	Pure Oil Producing Co., Mt. Pleasant, Mich.	1	tank	15%	750
3	6- 4	47,141	Columbia Oil & Gas Co., Mt. Pleasant, Mich.	4	cbys.	15%	53
4	6- 4	46,936	Lawrence Lee, Midland, Mich.	1	tank	15%	750
5	6- 7	47,527	Cincinnati Chem. Co.,				
6	6- 7	47,522	Columbia Oil & Gas Co., Shepherd, Mich.	6	cbys.	15%	80
7	6- 9	47,629	Lawrence Lee, Midland, Mich.	1	tank	15%	750
8	6-11	47,869	Pure Oil Co., Mt. Pleasant, Mich.	1	tank	15%	750
9	6-13	47,850	Ford Motor Co., Detroit, Mich.	GATX	1766	18° B.	16,700
10	6-13	48,065	Pure Oil	1	W.	15%	750
11	6-15	48,270	Pure Oil Co., Mt. Pleasant, Mich.	1	W.	15%	750
12	6-16	48,106	Chippewa Oil & Gas Co., Midland, Mich.	1	500 gal.	15%	750
13	6-17	48,343	Mt. Pleasant Oil & Gas Co., Mt. Pleasant, Mich.	1	500 gal.	15%	750
14	6-17	48,519	Pure Oil Co., Mt. Pleasant, Mich.	1	500 gal.	15%	750
15	6-16	48,343	W. L. McClanahan, Mt. Pleasant, Mich.	1	500 gal.	15%	750
16	6-18	48,537	Lawrence Lee, Midland, Mich.	1	500 gal.	15%	750
17	6-18	48,563	Talbot Oil Co., Midland, Mich.	1	500 gal.	15%	750
18	6-20	48,681	Pure Oil Co., Mt. Pleasant, Mich.	1	500 gal.	15%	750
19	6-20	48,634	Lawrence Lee, Midland, Mich.	1	500 gal.	15%	750
20	6-20	48,700	The Gorden Oil Co., Mt. Pleasant, Mich.	1	500 gal.	15%	750

11	6-15	48,270	Pure Oil Co., Mt. Pleasant, Mich.	1	W.	15%	750
12	6-16	48,106	Chippewa Oil & Gas Co., Midland, Mich.	1	500 gal.	15%	750
13	6-17	48,343	Mt. Pleasant Oil & Gas Co., Mt. Pleasant, Mich.	1	500 gal.	15%	750
14	6-17	48,519	Pure Oil Co., Mt. Pleasant, Mich.	1	500 gal.	15%	750
15	6-16	48,343	W. L. McClanahan, Mt. Pleasant, Mich.	1	500 gal.	15%	750
16	6-18	48,537	Lawrence Lee, Midland, Mich.	1	500 gal.	15%	750
17	6-18	48,563	Talbot Oil Co., Midland, Mich.	1	500 gal.	15%	750
18	6-20	48,681	Pure Oil Co., Mt. Pleasant, Mich.	1	500 gal.	15%	750
19	6-20	48,634	Lawrence Lee, Midland, Mich.	1	500 gal.	15%	750
20	6-20	48,700	The Gorden Oil Co., Mt. Pleasant, Mich.	1	500 gal.	15%	750
21	6-21	48,751	Pure Oil Co., Mt. Pleasant, Mich.	1	1000 gal.	15%	1,500
22	6-22	48,853	Stork Oil Co., Isabella County	1	500 gal.	15%	750
23	6-22	48,879	Pure Oil Co., Mt. Pleasant, Mich.	1	1000 gal.	15%	1,500
24	6-23	49,001	Pure Oil Co., Mt. Pleasant, Mich.	1	1000 gal.	15%	1,500
25	6-24	49,002	Pure Oil Co., Mt. Pleasant, Mich.	1	1000 gal.	15%	1,500
26	6-25	49,003	Pure Oil Co., Mt. Pleasant, Mich.	1	1000 gal.	15%	1,500
27	6-25	49,236	Michigan Gas & Oil Co., Mt. Pleasant, Mich.	1	500 gal.	15%	750
28	6-27	49,232	Pure Oil Co., Mt. Pleasant, Mich.	1	1000 gal.	15%	1,500
29	6-28	49,380	Lupher Drilling Co., Mt. Pleasant, Mich.	2	cbys.	15%	25
30	6-28	49,455	Ohio Producing & Refining Co., Mt. Pleasant, Mich.	1	500 gal.	15%	750
31	6-28	49,664	Pure Oil Co., Mt. Pleasant	1	1000 gal.	15%	1,500
32	6-29	49,422	Lawrence Lee, Midland, Mich.	1	1000 gal.	15%	1,500
33	6-30	49,666	Pure Oil Co., Mt. Pleasant	1	1000 gal.	15%	1,500
34	6-30	49,550	General Dry Batteries, Cleveland, Ohio.	GATX	1765	18°	16,500
35	6-30	48,981	Lawrence Lee, Midland, Mich. (Ohio)	1	500 gal.	15%	750
			44 gal. Arsenic Pure Oil (notation below)				
			28 gal. Arsenic Misc. (notation below)				

PLAINTIFF'S EXHIBIT 305

First Treatment of Pure Oil Co. Well with Inhibited Acid, as reported by Robert Quinlan

The well treated was known as the Fox, either No. 5 or No. 6. I believe it was No. 5, but am not positive. This can be ascertained from State Conservation Department agents at Mt. Pleasant.

At the time I was employed in the Physics Laboratory of The Dow Chemical Company, under supervision of Mr. J. J. Grebe. On February 10, 1932 (the day before the well was treated) Mr. R. T. Sanford called me on the telephone and asked me to come to his office. I went to Mr. Sanford's office, where he told me that arrangements had been made to treat one of Pure Oil Company's wells with acid, and instructed me to get ready a tank wagon load of hydrochloric acid which was to be diluted to about 15% strength and was to have arsenic acid added to it as inhibitor, the amount of the latter to be 2 gallons of arsenic acid to 500 gallons of acid.

On the next morning (February 11, 1932) I obtained one of The Dow Chemical Company's tank wagons, on which was a 36 inches diameter by 12 feet long horizontal wood tank. This tank wagon was hauled by a truck. First I went with the tank wagon to the Lead Arsenate Plant of The Dow Chemical Company, where I got 2 gallons of arsenic acid and poured it into the tank. Then I went with the tank wagon to the Chlorbenzol Plant, where 19 inches of water was first run into the tank and then 17 inches of strong (about 33% HCl) hydrochloric acid. This gave a diluted solution in the tank which tested 10° Beaumé by hydrometer.

Before leaving the Dow plant I got a pair of rubber gloves from Mr. Sanford's car, which he had told me were there. I rode on the truck which hauled the tank wagon of acid out to the well. After we arrived there Mr. San-

ford also came in his own car. A representative of the Pure Oil Company was at the well, whom I afterward found to be a Mr. Albert Lenz or Linz, then local field superintendent for the Pure Oil Company. He had two laborers there, also. The rods and valves had been pulled when we arrived. Upon arrival at the well I measured the depth of acid in the tank, using a new rule which Mr. Sanford supplied. Then I helped prepare and prime a siphon for feeding the acid into the well pipe. A 1-¼ inch rubber hose, about 40 feet long, was used. I placed one end of the hose in the acid tank and held up the other end while one of the laborers filled the hose with oil which he drew into a pail from an oil tank at hand. When the hose was filled with oil I pushed it down into the well pipe far enough to take up all of the slack lying on the ground. The acid ran into the well through the rubber hose, being continued until the depth of acid in the tank had dropped 10 inches. This amounted to about 125 gallons. The hose was then lifted out of the well pipe and tied up so as not to lose the prime of the siphon. The acid tank wagon was left at the well, and Mr. Sanford left instructions to make additional treatments of 125 gallons of acid at successive intervals. I rode back to Midland with Mr. Sanford, and did not return to make any further treatments of this well. However, I was the only man present having rubber gloves when the first treatment with acid was made, and I measured the acid tank, helped start the siphon, placed the hose in the well pipe and held it while the acid ran in during this first treatment.

Robert J. Quinlan.

Sworn to and subscribed before me this 5th day of December, 1932.

Geneva Turner,
Notary Public.

My commission expires July 7, 1934.

PLAINTIFF'S EXHIBIT 328

TABLE 1

Treat. No.	Company Name	Well Name	Date Treated	Acid Gals. Used	Gauge—C. F. Before Acid	Gauge—C. F. After Acid	Per-cent Increase	Cu. Ft. Per Gal. of Acid
491	Stanolind Oil & Gas Co.	Cal Merchant #2	9/22/37	3,000	3,000,000	6,800,000	127	1267
409	Cities Service Oil Co.	Hoerner #1	8/17/37	3,000	3,000,000	7,800,000	160	1600
528	Cities Service Oil Co.	Deahl #6	1/12/38	8,000	2,480,000	10,300,000	315	977
404	Canadian River Gas Co.	Bivin A #2	9/13/37	4,000	7,000,000	9,000,000	29	500
440	Shell Petroleum Co.	Russell #1	9/17/37	5,000	6,885,000	13,168,000	91	1257
455	Shamrock Oil & Gas Co.	Sneed #8	10/ 5/37	10,000	6,800,000	31,800,000	368	2500
463	P.E.P.L. Co.	Mesterson #1	10/21/37	10,000	5,400,000	34,400,000	537	2900
483	Phillips Petroleum Co.	Jones #3	12/14/37	5,000	7,000,000	25,242,000	261	3648
486	Texoma Natural Gas Co.	Deahl #2	12/27/37	5,000	6,300,000	12,000,000	90	1140
487	Texoma Natural Gas Co.	Texas Fee #3	12/29/37	5,000	6,000,000	11,500,000	92	1100
488	Shell Petroleum Co.	Longaneker #1	1/ 1/38	8,000	3,800,000	16,500,000	334	1587
489	Phillips Petroleum Co.	Clark Gable #2	1/ 1/38	5,000	6,800,000	27,562,000	305	4152
511	Phillips Petroleum Co.	Jones A #1	5/ 9/38	5,000	4,690,000	38,698,000	725	6802
526	Phillips Petroleum Co.	Jones #696-1	5/23/38	5,000	6,650,000	33,300,000	401	5330
401	Shamrock Oil & Gas Co.	J. T. Sneed #6	7/30/37	4,000	12,000,000	81,000,000	575	17250
415	Phillips Petroleum Co.	Ada #1	8/19/37	10,000	11,600,000	33,130,000	186	2153
420	Shell Petroleum Co.	Lucas #1	8/26/37	5,000	13,000,000	24,835,000	91	2367
429	Shell Petroleum Co.	Phillips #1	9/10/37	5,000	7,300,000	21,436,000	193	2827
434	Shamrock Oil & Gas Co.	McDowell #1	9/13/37	10,000	12,000,000	44,000,000	267	3200
444	Shell Petroleum Co.	Kraker #1	9/26/37	5,500	8,314,000	17,335,000	109	1644
446	Phillips Petroleum Co.	Preston #1	9/26/37	5,000	11,600,000	17,261,000	49	1132
456	Phillips Petroleum Co.	Loeber #1	10/ 6/37	10,000	9,900,000	29,974,000	203	2007
465	Shamrock Oil & Gas Co.	Sneed #9	11/ 4/37	10,000	9,000,000	59,000,000	556	5000
470	Phillips Petroleum Co.	Stanhope #1	11/13/37	10,000	14,000,000	37,213,000	166	2321
476	Shell Petroleum Co.	Wilbar #1	11/25/37	5,000	9,000,000	14,421,000	60	1084
527	Phillips Petroleum Co.	Fields #1	5/24/38	5,000	7,280,000	16,147,000	122	1773
368	Phillips Petroleum Co.	Pythian #1	5/10/37	5,000	25,000,000	45,101,000	80	4020
375	Phillips Petroleum Co.	Mary Beth #1	6/ 4/37	5,000	25,900,000	49,350,000	91	4690
386	Phillips Petroleum Co.	Sturdy #1	6/23/37	10,000	27,700,000	61,619,000	122	3392
390	Shamrock Oil & Gas Co.	Stewart #1	7/10/37	10,000	19,000,000	63,000,000	232	4400
393	Phillips Petroleum Co.	Marsh #1	7/17/37	10,000	16,000,000	56,000,000	250	4000
396	Phillips Petroleum Co.	Emily Nell #1	7/24/37	10,000	17,000,000	51,411,000	202	3441
398	Shell Petroleum Co.	A. Miller #1	7/26/37	5,000	23,200,000	30,930,000	33	1546
400	Shamrock Oil & Gas Co.	C. Jones #1	7/27/37	15,000	17,000,000	28,200,000	66	747
410	Shell Petroleum Co.	E. Miller #1A	8/18/37	5,000	21,910,000	36,007,000	64	2819
452	Shamrock Oil & Gas Co.	Sneed #1	10/ 1/37	10,000	28,537,000	41,305,000	45	1277
461	Phillips Petroleum Co.	Ochsner #1	10/20/37	5,000	24,250,000	49,834,000	105	5117
471	Shamrock Oil & Gas Co.	Shary #1	11/17/37	3,000	18,800,000	52,800,000	181	11333
477	Phillips Petroleum Co.	Ansley #1	11/28/37	10,000	16,000,000	47,021,000	194	3102
399	Shamrock Oil & Gas Co.	A. Sheed #2	8/ 9/37	10,000	31,600,000	78,900,000	150	4730
408	Shell Petroleum Co.	Hohlman #1	8/15/37	5,000	35,000,000	61,795,000	77	5359
413	Phillips Petroleum Co.	Stigall #1	7/24/37	5,000	31,700,000	80,179,000	153	9696
424	Phillips Petroleum Co.	Coffee #1	8/30/37	5,000	37,000,000	74,518,000	101	7504
426	Phillips Petroleum Co.	Venable #1	9/ 2/37	5,000	33,000,000	60,413,000	83	5483
430	Phillips Petroleum Co.	Texas #1	9/12/37	5,000	42,100,000	60,197,000	43	3619
448	Phillips Petroleum Co.	Ray #1	9/29/37	5,000	40,000,000	67,466,000	69	5493
490	Shamrock Oil & Gas Co.	Sneed #10	1/ 4/38	6,000	80,000,000	136,000,000	70	9333

TABLE 2

Pretreatment Open Flow	No. Wells in Group	Actual Average Open Flow	Acid Data No. Stages	Acid Data No. Gallons	After Treatment Data Open Flow	After Treatment Data Percent Increase	Cost Per One Million Ft. Gas Original Open Flow A	Cost Per One Million Ft. Gas Increase Due to Acid B	Cost Per One Million Ft. Gas Percent B of A

398	Shell Petroleum Co.	A. Miller #1	7/26/37	5,000	23,200,000	30,930,000	33	1546
400	Shamrock Oil & Gas Co.	C. Jones #1	7/27/37	15,000	17,000,000	28,200,000	66	747
410	Shell Petroleum Co.	E. Miller #1A	8/18/37	5,000	21,910,000	36,007,000	64	2819
452	Shamrock Oil & Gas Co.	Sneed #1	10/ 1/37	10,000	28,537,000	41,305,000	45	1277
461	Phillips Petroleum Co.	Ochsner #1	10/20/37	5,000	24,250,000	49,834,000	105	5117
471	Shamrock Oil & Gas Co.	Shary #1	11/17/37	3,000	18,860,000	52,800,000	181	11333
477	Phillips Petroleum Co.	Ansley #1	11/28/37	10,000	16,000,000	47,021,000	194	3102
399	Shamrock Oil & Gas Co.	A. Sheed #2	8/ 9/37	10,000	31,600,000	78,900,000	150	4730
408	Shell Petroleum Co.	Hohlman #1	8/15/37	5,000	35,000,000	61,795,000	77	5359
413	Phillips Petroleum Co.	Stigall #1	7/24/37	5,000	31,700,000	80,179,000	153	9696
424	Phillips Petroleum Co.	Coffee #1	8/30/37	5,000	37,000,000	74,518,000	101	7504
426	Phillips Petroleum Co.	Venable #1	9/ 2/37	5,000	33,000,000	60,413,000	83	5483
430	Phillips Petroleum Co.	Texas #1	9/12/37	5,000	42,100,000	60,197,000	43	3619
448	Phillips Petroleum Co.	Ray #1	9/29/37	5,000	40,000,000	67,466,000	69	5493
490	Shamrock Oil & Gas Co.	Sneed #10	1/ 4/38	6,000	80,000,000	136,000,000	70	9333

TABLE 2

Pretreatment Open Flow	No. Wells in Group	Actual Average Open Flow	Acid Data No. Stages	Acid Data No. Gallons	After Treatment Data Open Flow	After Treatment Data Percent Increase	Cost Per One Million Ft. Gas Original Open Flow A	Cost Per One Million Ft. Gas Increase Due to Acid B	Cost Per One Million Ft. Gas Percent B of A
0-3 million	3	2,826,666	1.7	4,666	8,300,000	194	$7,067	$238	3.3
3-7 million	11	6,120,454	2.3	6,090	23,015,454	276	3,268	98	3.0
7-15 million	12	10,416,166	2.4	7,042	32,979,333	217	1,923	83	4.3
15-30 million	13	21,561,307	2.6	7,923	47,121,384	119	925	81	8.7
Over 30 million	8	41,300,000	2.1	5,750	77,433,500	87	484	43	8.8
Average or Total	47	17,267,872	2.3	6,691	40,550,383	135	$1,156	$ 77	6.6%

Plaintiff's Exhibit 329

PLAINTIFF'S EXHIBIT 329

RESULTS OF ACIDIZING GAS WELLS IN TEXAS PANHANDLE

Treatment No.	Customer	Well Name	County	Location Sec.	Blk.	Sur.	Date Treated	Gallons Acid Used	Type Acid	Gauge Cu. Ft./ Day Before	After	% Increase	Cu. Ft. Increase per Gallon Acid	Cu. Ft. Increase per $ Acid	Cost Acid Compressor Water	T
368	Phillips Pet. Co.	Pythian #1	Moore	23	44	H&TC	5/10/37	5,000	XX	25,000,000	45,101,000	80	4,020	20,640	974.61	1,3
374	Phillips Pet. Co.	E. W. Nelson #1	Moore	282		T&NO	5/28/37	5,000	XX	10,746,000	18,615,000	73	1,575	7,820	932.96	1,0
375	Phillips Pet. Co.	Mary Beth #1	Moore	17	M16	AB&M	6/ 4/37	5,000	XX	25,900,000	49,350,000	91	4,690	23,540	995.44	1,0
378	Phillips Pet. Co.	John Purdy #1	Moore	164	3T	T&NO	6/ 9/37	5,000	XX	27,700,000	46,678,000	69	3,797	19,070	995.44	1,0
386	Phillips Pet. Co.	Sturdy #1	Moore	24	M1	EL&R	6/23/37	10,000	XX	27,700,000	61,619,000	122	3,392	19,560	1,734.72	1,8
393	Phillips Pet. Co.	Stanley Marsh #1	Moore	316	44	H&TC	7/17/37	10,000	XX	16,000,000	56,000,000	250	4,000	23,060	1,734.72	1,8
396	Phillips Pet. Co.	Emily Nell #1	Moore	310	44	H&TC	7/24/37	10,000	XX	20,700,000	51,411,000	148	3,071	17,840	1,724.21	1,7
398	Shell Pet. Corp.	A. L. Miller #1	Moore	154	3T	T&NO	7/26/37	5,000	XX	23,200,000	30,930,000	33	1,546	8,280	932.96	1,0
390	Shamrock Oil & Gas	Mary Stewart #1	Hutch	19	M16	AB&M	7/10/37	10,000	XX	19,000,000	63,000,000	231	4,400	21,680	2,028.60	2,1
400	Shamrock Oil & Gas	C. R. Jones #1	Moore	166	3T	T&NO	7/31/37	15,000	XX	13,000,000	28,600,000	120	1,040	5,540	2,817.67	2,8
401	Shamrick Oil & Gas	J. T. Sneed #6	Moore	48	6T	T&NO	7/30/37	10,000	XX	12,000,000	81,000,000	575	6,900	36,940	1,868.52	2,4
402	Shamrock Oil & Gas	A. Sneed #1	Moore	32	6T	T&NO	7/23/37	4,000	XX	31,000,000	31,000,000	0	0	0	999.00	1,0
404	Canadian River Gas	Bivens A2	Moore	33	1	EL&RR	8/ 3/37	4,000	XX	7,000,000	46,357,000	562	9,839	42,350	929.04	1,2
399	Shamrock Oil & Gas	A. Sneed #2	Moore	21	6T	T&NO	7/20/37	10,000	XX	31,600,000	78,900,000	150	4,730	25,900	1,825.74	2,4
407	Shamrock Oil & Gas	J. T. Sneed #4	Moore	39	6T	T&NO	7/20/37	4,000	XX	7,500,000	7,500,000	0	0	0	819.00	8
495	Shamrock Oil & Gas	J. T. Sneed #7	Moore	3	M3	Wozier	8/ 7/37	4,000	XX	1,800,000	1,800,000	0	0	0	819.00	8
408	Shell Pet. Corp.	Hohman #1	Moore	227	3T	T&NO	8/15/37	5,000	XX	35,000,000	61,795,000	77	5,359	28,740	932.96	1,0
409	Cities Service Oil	Hoerner #1	Gray	217	213	H&CN	8/17/37	3,000	XX	3,000,000	7,800,000	160	1,600	8,230	583.10	6
410	Shell Pet. Corp.	E. Miller A#1	Moore	146	3T	T&NO	8/18/37	5,000	XX	21,910,000	36,007,000	64	2,819	14,600	965.23	1,0
413	Phillips Pet. Co.	W. C. Stigall #1	Moore	280	44	H&TC	8/17/37	5,000	XX	31,700,000	80,179,000	159	10,100	54,100	932.96	1,0
415	Phillips Pet. Co.	Ada #1	Moore	151	3T	T&NO	8/19/37	10,000	XX	11,600,000	33,130,000	186	2,153	14,370	1,499.40	1,5
420	Shell Pet. Corp.	Lucas #1	Hutch	6		Swisher	8/26/37	5,000	X	13,000,000	24,835,000	91	2,367	12,700	932.96	1,0
423	Phillips Pet. Co.	W. Coffee #1	Moore	355	44	H&TC	8/30/37	5,000	XX	35,000,000	74,518,000	113	7,900	42,350	932.96	1,0
426	Phillips Pet. Co.	R. H. Venable #1	Moore	203	3T	T&NO	9/ 2/37	5,000	XX	33,000,000	60,413,000	83	5,485	29,440	932.96	1,0
429	Shell Pet. Corp.	Ottis Phillips A#1	Hutch	2	M16	AB&M	9/10/37	5,000	XX	7,300,000	21,436,000	194	2,827	15,160	932.96	1,0
430	Phillips Pet. Co.	Texas #1	Moore	113	3T	T&NO	9/12/37	5,000	XX	42,100,000	63,197,000	50	4,206	22,620	932.96	1,0
434	Shamrock Oil & Gas	McDowell #1	Moore	13	M16	T&NO	9/13/37	10,000	XX	12,000,000	28,118,000	134	1,612	9,350	1,724.31	1,7
440	Shell Pet. Corp.	W. L. Russell #1	Moore	5	M16	AB&M	9/17/37	5,000	XX	6,885,000	13,168,000	91	1,257	6,730	932.96	1,0
441	Stanolind Oil & Gas Co.	C. Merchant #4	Hutch	38	47	H&TC	9/22/37	2,000	XX	3,000,000	6,800,000	126	2,530	12,020	376.00	4
444	Shell Pet. Corp.	Kraker #1	Moore	149	3T	T&NO	9/26/37	5,500	XX	8,314,000	17,335,000	108	1,640	8,090	1,117.50	1,1
446	Phillips Pet. Co.	Preston #1	Moore	278	44	H&TC	9/26/37	5,000	XX	11,600,000	17,261,000	49	1,132	6,097	932.96	1,2
448	Phillips Pet. Co.	Ray #1	Moore	199	3T	T&NO	9/29/37	5,000	XX	40,000,000	67,466,000	69	5,495	29,500	932.96	1,0
452	Shamrock Oil & Gas	J. T. Sneed #1	Moore	32	6T	T&NO	10/ 1/37	10,000	XX	28,537,000	41,305,000	45	1,277	7,265	1,758.46	2,3
455	Shamrock Oil & Gas	J. T. Sneed #8	Moore	41	6T	T&NO	10/ 5/37	10,000	XX	6,800,000	31,800,000	368	2,500	14,240	1,755.96	2,3
456	Phillips Pet. Co.	Nellie Loeber #1	Moore	35	2	CC&SF	10/ 6/37	10,000	XX	9,000,000	31,800,000	254	2,280	13,230	1,724.72	1,7
461	Phillips Pet. Co.	Oshner #1	Moore	278	44	H&TC	10/20/37	5,000	XX	24,250,000	49,834,000	106	5,116	27,420	932.96	1,2
463	Panhandle Eastern Pipe Line Co.	Masterson 1-38	Moore	38	3	G&M	10/21/37	10,000	XX	6,350,000	31,524,000	396	2,517	11,960	2,102.10	2,4
465	Shamrock Oil & Gas	Sneed #9	Moore	8	M1	Morrison	11/ 4/37	10,000	XX	9,000,000	78,880,000	777	6,988	40,525	1,724.31	2,3
468	Panhandle Eastern Pipe Line Co.	Neild #1	Moore	18	44	H&TC	11/ 4/37	2,000	XX	7,000,000	34,000,000	386	13,500	50,300	465.50	5
469	Shamrock Oil & Gas	Thompson #1	Moore	23	44	H&TC	11/ 8/37	1,000	XX	18,000,000	18,000,000	0	0	0	238.00	3
470	Phillips Pet. Co.	Stanhope #1	Moore	231	3T	T&NO	11/13/37	10,000	XX	14,000,000	37,213,000	166	2,321	13,470	1,724.72	1,7
471	Shamrock Oil & Gas	Shary #1	Moore	187	3T	T&NO	11/17/37	3,000	XX	21,045,000	52,800,000	181	11,333	58,300	583.10	6
476	Shell Pet. Corp.	A. P. Wilbar #1	Moore	229	3T	T&NO	11/25/37	5,000	XX	9,000,000	14,421,000	60	1,084	5,820	932.96	1,0
477	Phillips Pet. Co.	R. Ansley #1	Moore	308	44	H&TC	4/28/37	10,000	XX	16,000,000	47,201,000	195	3,120	18,100	1,724.72	1,7
479	Shamrock Oil & Gas	Sneed #11	Moore	29	6T	T&NO	12/ 4/37	6,000	XX	9,000,000	18,000,000	100	1,500	15,000	1,156.00	1,3
483	Phillips Pet. Co.	C. R. Jones A#3	Moore	164	3T	T&NO	12/ 4/37	5,000	XX	7,000,000	25,242,000	261	3,648	19,570	932.96	1,0

Cu. Ft. Increase per $ Acid	Cost Acid Compressor Water	Total Cost	Increased Revenue/ Month	Pay Out in Months	Type Well
20,640	974.61	1,306.61	656.00	2.0	Sweet
7,820	932.96	1,004.96	20.50	49.0	Sour
23,540	995.44	1,067.44	60.93	17.5	Sour
19,070	995.44	1,067.44	49.50	21.6	Sour
19,560	1,734.72	1,806.72	88.40	20.4	Sour
23,060	1,734.72	1,806.72	104.20	17.3	Sour
17,840	1,724.21	1,796.21	80.00	22.5	Sour
8,280	932.96	1,004.96	20.12	50.0	Sour
21,680	2,028.60	2,100.60	114.70	18.3	Sour
5,540	2,817.67	2,889.67	40.60	73.7	Sour
36,940	1,868.52	2,460.52	2,264.00	1.1	Sweet
0	999.00	1,071.00	0	—	Sweet
42,350	929.04	1,261.04	1,291.00	1.0	Sweet
25,900	1,825.74	2,417.74	1,551.00	1.6	Sweet
0	819.00	881.00	0	—	Sweet
0	819.00	881.00	0	—	Sweet
28,740	932.96	1,004.96	69.97	14.4	Sour
8,230	583.10	655.10	147.60	3.9	Sweet
14,600	965.23	1,037.23	36.70	28.2	Sour
54,100	932.96	1,004.96	126.10	8.0	Sour
14,370	1,499.40	1,571.40	56.05	28.1	Sour
12,700	932.96	1,004.96	30.90	32.5	Sour
42,350	932.96	1,004.96	103.00	9.8	Sour
29,440	932.96	1,004.96	71.80	14.0	Sour
15,160	932.96	1,004.96	36.80	27.3	Sour
22,620	932.96	1,004.96	54.90	18.3	Sour
9,350	1,724.31	1,796.31	41.90	42.8	Sour
6,730	932.96	1,004.96	16.37	61.4	Sour
12,020	376.00	448.00	32.20	14.0	Sour
8,090	1,117.50	1,189.50	23.46	50.7	Sour
6,097	932.96	1,264.96	185.40	6.8	Sweet
29,500	932.96	1,004.96	71.43	14.1	Sour
7,265	1,758.46	2,350.46	418.00	5.6	Sweet
14,240	1,755.96	2,347.96	820.0	2.9	Sweet
13,230	1,724.72	1,796.72	58.0	30.9	Sour
27,420	932.96	1,264.96	841.00	1.5	Sweet
11,960	2,102.10	2,434.10	757.50	3.2	Sweet
40,525	1,724.31	2,316.31	2,293.00	1.0	Sweet
50,300	465.50	537.50	885.80	.6	Sweet
0	238.00	310.00	0	—	Sweet
13,470	1,724.72	1,796.72	60.50	29.7	Sour
58,300	583.10	655.00	82.75	7.9	Sour
5,820	932.96	1,004.96	14.14	7.1	Sour
18,100	1,724.72	1,796.72	81.30	22.1	Sour
15,000	1,156.00	1,300.00	295.00	4.4	Sweet
19,570	932.96	1,004.96	47.53	21.1	Sour
0	932.96	1,004.96	0	—	Sweet

378	Phillips Pet. Co.	[illegible] #1	Moore	164	31	T&NO	6/ 9/37	5,000	XX	27,700,000	40,678,000	69	3,791	19,070
386	Phillips Pet. Co.	Sturdy #1	Moore	24	M1	EL&R	6/23/37	10,000	XX	27,700,000	61,619,000	122	3,392	19,560
393	Phillips Pet. Co.	Stanley Marsh #1	Moore	316	44	H&TC	7/17/37	10,000	XX	16,000,000	56,000,000	250	4,000	23,060
396	Phillips Pet. Co.	Emily Nell #1	Moore	310	44	H&TC	7/24/37	10,000	XX	20,700,000	51,411,000	148	3,071	17,840
398	Shell Pet. Corp.	A. L. Miller #1	Moore	154	3T	T&NO	7/26/37	5,000	XX	23,200,000	30,930,000	33	1,546	8,280
390	Shamrock Oil & Gas	Mary Stewart #1	Hutch	19	M16	AB&M	7/10/37	10,000	XX	19,000,000	63,000,000	231	4,400	21,680
400	Shamrock Oil & Gas	C. R. Jones #1	Moore	166	3T	T&NO	7/31/37	15,000	XX	13,000,000	28,600,000	120	1,040	5,540
401	Shamrick Oil & Gas	J. T. Sneed #6	Moore	48	6T	T&NO	7/30/37	10,000	XX	12,000,000	81,000,000	575	6,900	36,940
402	Shamrock Oil & Gas	A. Sneed #1	Moore	32	6T	T&NO	7/23/37	4,000	XX	31,000,000	31,000,000	0	0	0
404	Canadian River Gas	Bivens A2	Moore	33	1	EL&RR	8/ 3/37	4,000	XX	7,000,000	46,357,000	562	9,839	42,350
399	Shamrock Oil & Gas	A. Sneed #2	Moore	21	6T	T&NO	7/20/37	10,000	XX	31,600,000	78,900,000	150	4,730	25,900
407	Shamrock Oil & Gas	J. T. Sneed #4	Moore	39	6T	T&NO	7/20/37	4,000	XX	7,500,000	7,500,000	0	0	0
405	Shamrock Oil & Gas	J. T. Sneed #7	Moore	3	M3	Wozier	8/ 7/37	4,000	XX	1,800,000	1,800,000	0	0	0
408	Shell Pet. Corp.	Hohman #1	Moore	227	3T	T&NO	8/15/37	5,000	XX	35,000,000	61,795,000	77	5,359	28,740
409	Cities Service Oil	Hoerner #1	Gray	217	213	H&CN	8/17/37	3,000	XX	3,000,000	7,800,000	160	1,600	8,230
410	Shell Pet. Corp.	E. Miller A#1	Moore	146	3T	T&NO	8/18/37	5,000	XX	21,910,000	36,007,000	64	2,819	14,600
413	Phillips Pet. Co.	W. C. Stigall #1	Moore	280	44	H&TC	8/17/37	5,000	XX	31,700,000	80,179,000	159	10,100	54,100
415	Phillips Pet. Co.	Ada #1	Moore	151	3T	T&NO	8/19/37	10,000	XX	11,600,000	33,130,000	186	2,153	14,370
420	Shell Pet. Corp.	Lucas #1	Hutch	6		Swisher	8/26/37	5,000	X	13,000,000	24,835,000	91	2,367	12,700
423	Phillips Pet. Co.	W. Coffee #1	Moore	355	44	H&TC	8/30/37	5,000	XX	35,000,000	74,518,000	113	7,900	42,350
426	Phillips Pet. Co.	R. H. Venable #1	Moore	203	3T	T&NO	9/ 2/37	5,000	XX	33,000,000	60,413,000	83	5,485	29,440
429	Shell Pet. Corp.	Ottis Phillips A#1	Hutch	2	M16	AB&M	9/10/37	5,000	XX	7,300,000	21,436,000	194	2,827	15,160
430	Phillips Pet. Co.	Texas #1	Moore	113	3T	T&NO	9/12/37	5,000	XX	42,100,000	63,197,000	50	4,206	22,620
434	Shamrock Oil & Gas	McDowell #1	Moore	13	M16	T&NO	9/13/37	10,000	XX	12,000,000	28,118,000	134	1,612	9,350
440	Shell Pet. Corp.	W. L. Russell #1	Moore	5	M16	AB&M	9/17/37	5,000	XX	6,885,000	13,168,000	91	1,257	6,730
441	Stanolind Oil & Gas Co.	C. Merchant #4	Hutch	38	47	H&TC	9/22/37	2,000	XX	3,000,000	6,800,000	126	2,530	12,020
444	Shell Pet. Corp.	Kraker #1	Moore	149	3T	T&NO	9/26/37	5,500	XX	8,314,000	17,335,000	108	1,640	8,090
446	Phillips Pet. Co.	Preston #1	Moore	278	44	H&TC	9/26/37	5,000	XX	11,600,000	17,261,000	49	1,132	6,097
448	Phillips Pet. Co.	Ray #1	Moore	199	3T	T&NO	9/29/37	5,000	XX	40,000,000	67,466,000	69	5,495	29,500
452	Shamrock Oil & Gas	J. T. Sneed #1	Moore	32	6T	T&NO	10/ 1/37	10,000	XX	28,537,000	41,305,000	45	1,277	7,265
455	Shamrock Oil & Gas	J. T. Sneed #8	Moore	41	6T	T&NO	10/ 5/37	10,000	XX	6,800,000	31,800,000	368	2,500	14,240
456	Phillips Pet. Co.	Nellie Loeber #1	Moore	35	2	CC&SF	10/ 6/37	10,000	XX	9,000,000	31,800,000	254	2,280	13,230
461	Phillips Pet. Co.	Oshner #1	Moore	278	44	H&TC	10/20/37	5,000	XX	24,250,000	49,834,000	106	5,116	27,420
463	Panhandle Eastern Pipe Line Co.	Masterson 1-38	Moore	38	3	G&M	10/21/37	10,000	XX	6,350,000	31,524,000	396	2,517	11,960
465	Shamrock Oil & Gas	Sneed #9	Moore	8	M1	Morrison	11/ 4/37	10,000	XX	9,000,000	78,880,000	777	6,988	40,525
468	Panhandle Eastern Pipe Line Co.	Neild #1	Moore	18	44	H&TC	11/ 4/37	2,000	XX	7,000,000	34,000,000	386	13,500	50,300
469	Shamrock Oil & Gas	Thompson #1	Moore	23	44	H&TC	11/ 8/37	1,000	XX	18,000,000	18,000,000	0	0	0
470	Phillips Pet. Co.	Stanhope #1	Moore	231	3T	T&NO	11/13/37	10,000	XX	14,000,000	37,213,000	166	2,321	13,470
471	Shamrock Oil & Gas	Shary #1	Moore	187	3T	T&NO	11/17/37	3,000	XX	21,045,000	52,800,000	181	11,333	58,300
476	Shell Pet. Corp.	A. P. Wilbar #1	Moore	229	3T	T&NO	11/25/37	5,000	XX	9,000,000	14,421,000	60	1,084	5,820
477	Phillips Pet. Co.	R. Ansley #1	Moore	308	44	H&TC	4/28/37	10,000	XX	16,000,000	47,201,000	195	3,120	18,100
479	Shamrock Oil & Gas	Sneed #11	Moore	29	6T	T&NO	12/ 4/37	6,000	XX	9,000,000	18,000,000	100	1,500	15,000
483	Phillips Pet. Co.	C. R. Jones A#3	Moore	164	3T	T&NO	12/ 4/37	5,000	XX	7,000,000	25,242,000	261	3,648	19,570
486	Texoma Nat. Gas Co.	W. G. Deahl #1	Hutch	3	3	AB&M	12/27/37	5,000	XX	6,300,000	6,300,000	0	0	0
487	Texoma Nat. Gas Co.	Texas Fee #3	Carson	59	4	I&GN	12/29/37	4,000	XX	7,598,000	7,598,000	0	0	0
488	Shell Pet. Corp.	E. R. Longanecker #1	Moore	150	3T	T&NO	1/ 1/38	8,000	XX	3,800,000	16,500,000	334	1,588	9,033
489	Phillips Pet. Co.	Clark Gable #2	Moore	356	44	H&TC	1/ 1/38	5,000	XX	6,800,000	27,562,000	306	4,152	22,260
490	Shamrock Oil & Gas	Sneed #10	Moore	49	6T	T&NO	1/ 4/38	6,000	XX	80,000,000	136,000,000	70	9,333	51,300
492	Carl M. Smith & J. R. Roby	Meers #1	Gray	107	3	I&GN	1/ 6/38	1,000	XX	1,500,000	1,500,000	0	0	0
493	Cities Service Oil	Deahl #8	Carson	6	B	AB&M	1/12/38	9,000	XX	2,480,000	7,820,000	315	869	3,220
496	Sinclair Prairie Oil Co.	Merchant Vacuum #5	Hutch	37	47	H&TC	1/24/38	5,000	XX	16,000,000	30,669,000	92	3,200	17,150
497	Shamrock Oil & Gas	Kelly #1	Moore	212	3T	H&TC	1/24/38	4,000	XXF	21,000,000	47,500,000	126	6,620	31,980
500	Phillips Pet. Co.	Shellburg #1	Moore	110	3T	T&NO	2/ 3/38	10,000	X	4,760,000	6,886,000	45	213	1,424
503	Texhoma Nat. Gas Co.	Texas Fee #3	Carson	59	4	I&GN	3/ 8/38	5,000	X	6,000,000	11,338,000	89	1,068	6,050
506	Texhoma Nat. Gas Co.	Deahl E#1	Hutch	3	3	AB&M	3/23/38	5,000	X	6,300,000	9,786,000	55	872	4,317
507	Phillips Pet. Co.	J. F. Ward #1	Moore	320	44	H&TC	4/11/38	5,000	X	22,040,000	35,960,000	63	2,284	17,240
511	Phillips Pet. Co.	C. R. Jones #1	Moore	164	3T	T&NO	5/ 9/38	5,000	X	4,690,000	38,698,000	726	6,801	42,140
526	Phillips Pet. Co.	Jones 696 #1	Moore	189	3T	T&NO	5/23/38	5,000	XXF	6,650,000	33,300,000	401	5,330	28,570
527	Phillips Pet. Co.	R. D. Fields #1	Moore	247	3T	HT&BRR	5/24/38	5,000	XF	2,280,000	16,147,000	608	2,773	17,170
537	Phillips Pet. Co.	Makeig #1	Moore	309	44	H&TC	7/11/38	5,000	XFR	25,600,000	65,814,000	157	8,043	49,770
538	Canadian River Gas	Bivens A#15	Moore	76	2	G&M	7/13/38	5,000	XR	8,872,000	9,558,000	8	172	1,043
530	Phillips Pet. Co.	J. Lane #1	Hutch	3	B3	D&SE	6/15/38	700	XX	2,043,000	4,900,000	140	4,080	14,780
535	Phillips Pet. Co.	Garland #2	Hutch	77	46	H&TC	6/30/38	1,600	XX	5,500,000	7,400,000	35	1,187	5,616

19,560	1,734.72	1,806.72	88.40	20.4	Sour
23,060	1,734.72	1,806.72	104.20	17.3	Sour
17,840	1,724.21	1,796.21	80.00	22.5	Sour
8,280	932.96	1,004.96	20.12	50.0	Sour
21,680	2,028.60	2,100.60	114.70	18.3	Sour
5,540	2,817.67	2,889.67	40.60	73.7	Sour
36,940	1,868.52	2,460.52	2,264.00	1.1	Sweet
0	999.00	1,071.00	0	—	Sweet
42,350	929.04	1,261.04	1,291.00	1.0	Sweet
25,900	1,825.74	2,417.74	1,551.00	1.6	Sweet
0	819.00	881.00	0	—	Sweet
0	819.00	881.00	0	—	Sweet
28,740	932.96	1,004.96	69.97	14.4	Sour
8,230	583.10	655.10	147.60	3.9	Sweet
14,600	965.23	1,037.23	36.70	28.2	Sour
54,100	932.96	1,004.96	126.10	8.0	Sour
14,370	1,499.40	1,571.40	56.05	28.1	Sour
12,700	932.96	1,004.96	30.90	32.5	Sour
42,350	932.96	1,004.96	103.00	9.8	Sour
29,440	932.96	1,004.96	71.80	14.0	Sour
15,160	932.96	1,004.96	36.80	27.3	Sour
22,620	932.96	1,004.96	54.90	18.3	Sour
9,350	1,724.31	1,796.31	41.90	42.8	Sour
6,730	932.96	1,004.96	16.37	61.4	Sour
12,020	376.00	448.00	32.20	14.0	Sour
8,090	1,117.50	1,189.50	23.46	50.7	Sour
6,097	932.96	1,264.96	185.40	6.8	Sweet
29,500	932.96	1,004.96	71.43	14.1	Sour
7,265	1,758.46	2,350.46	418.00	5 6	Sweet
14,240	1,755.96	2,347.96	820.0	2.9	Sweet
13,230	1,724.72	1,796.72	58.0	30.9	Sour
27,420	932.96	1,264.96	841.00	1.5	Sweet
11,960	2,102.10	2,434.10	757.50	3.2	Sweet
40,525	1,724.31	2,316.31	2,293.00	1.0	Sweet
50,300	465.50	537.50	885.80	.6	Sweet
0	238.00	310.00	0	—	Sweet
13,470	1,724.72	1,796.72	60.50	29.7	Sour
58,300	583.10	655.00	82.75	7.9	Sour
5,820	932.96	1,004.96	14.14	7.1	Sour
18,100	1,724.72	1,796.72	81.30	22.1	Sour
15,000	1,156.00	1,300.00	295.00	4.4	Sweet
19,570	932.96	1,004.96	47.53	21.1	Sour
0	932.96	1,004.96	0	—	Sweet
0	758.03	830.03	0	—	Sweet
9,033	1,407.77	1,479.77	33.10	44.7	Sour
22,260	932.96	1,004.96	48.33	20.6	Sour
51,300	1,091.23	1,683.23	1,837.00	.9	Sweet
0	274.40	346.40	0	—	Sour
3,220	1,842.40	2,434.4	235.30	10.3	Sweet
17,150	932.96	1,004.96	38.20	26.3	Sour
31,980	758.03	830.03	68.75	12.1	Sour
1,424	1,495.24	1,567.24	5.54	283.3	Sour
6,050	808.01	1,400.01	174.80	8.0	Sweet
4,317	808.01	1,400.01	117.70	11.9	Sweet
17,240	808.01	880.01	36.17	24.3	Sour
42,140	808.01	880.01	88.50	10.0	Sour
28,570	932.96	1,004.96	69.11	14.5	Sour
17,170	808.01	880.01	36.00	24.4	Sour
49,770	808.01	880.01	104.50	8.4	Sour
1,043	658.07	1,250.67	22.33	5.6	Sweet
14,780	193.26	265.26	7.44	35.6	Sour
5,616	338.20	410.20	4.96	82.7	Sour

PLAINTIFF'S EXHIBIT 330

97 CONSECUTIVE ARBUCLE DOLOMITE WELLS TREATED BY DOWELL INCORPORATED IN KANSAS FROM MARCH TO SEPT. 1936 TOTALING 122 TREATMENTS

Tmt. No.	Owner of Well	Well Name & No.	Time Acid Was in Tubing/Hrs.	Add. Tmt. No.	Time Acid Was in Tubing/hrs	Total Time/Hrs Acid in Tubing
1802	Empire Oil & Ref.	Anderson #5	33:05	1605	20:00	53:05
1803	Empire Oil & Ref.	Kirkpatrick #5	6:55			6:55
1804	Sinclair	Kelly #1	3:00			3:00
1805	Continental Oil	J. L. Lansing #2	1:15			1:15
1807	Gulf Oil Corp.	Coffman #5	3:09			3:09
1808	Helmerick & Payne	H. L. Wartick #1	9:15	1760	2:55	12:10
1809	Gulf Oil Corp.	Keesling #4	23:25	1837	3:17	
				1868	6:28	33:10
1810	Sinclair	Sharp #5	1:53			1:53
1814	Gulf Oil Corp.	Knop #1	3:08			3:08
1815	Bradley Oil Co.	Wendell #2	2:00			2:00
1816	Empire Oil & Ref.	Burns #2	1:45			1:45
1818	Stanolind Oil & Gas	Figgers #1	29:30			29:30
1819	Mid-Continent Pet.	Hartle #7	0:30			0:30
1820	Skelly Oil Co.	Graham #4	0:45			est. 0:45
1822	Shell Ref. Co.	Community #4	1:25	1852	1:35	3:00
1824	Continental Oil	Gibson AFE 5541	1:53			1:53
1827	Continental Oil	Risse #11AFE 551	2:19			2:19
1828	Sinclair	Cross #1	5:45			5:45
1829	Carter Oil Co.	Groth #2	1:11			1:11
1830	Lario Oil & Gas	Boxberger #3	1:29	1652	1:12	2:41
1831	Hutchinson Oil & Gas	Wendell #5	3:48			3:48
1846	Continental Oil	Risse #10	1:35			1:35
1854	Continental Oil	Westerman #1	1:25			1:25
1855	Carter Oil Co.	Ogden #4	1:35			1:35
1857	Stanolind Oil & Gas	Eberhart #1	5:30			5:30
1859	Empire Oil & Ref.	Young #1	41:08	1876	11:55	
				1884	2:10	55:13
1860	Buchanan Tst.	Lancefield #1	7:05			7:05
1865	W. T. Southern	R. Berry #2	1:04			1:04
1875	Continental Oil	Ainsworth #2	4:20			4:20
1878	Coralena Oil Co.	Boomhower #1	5:20			5:20
1881	Stanolind Oil & Gas	Mitchell #5	9:53	1978	3:43	13:36
1883	Continental Oil	J. Jones #1	1:03			1:03
1885	Sinclair Prairie	Iserm #2	6:30	1904	12:00	
				1919	17:47	36:16
1886	Gulf Oil Corp.	Hartle #6	5:26	1928	3:02	8:28
1890	Empire Oil & Ref.	Janssen #1B	3:50	1912	3:50	7:40
1900	Empire Oil & Ref.	Burns #3	1:40	1917	1:35	3:15
1908	Skelly Oil Co.	Ehrlich #1	1:00			1:00
1909	Skelly Oil Co.	C. O. Sharp #2	1:15			1:15
1910	Empire Oil & Ref.	Proffitt #12	6:00	1940	2:15	8:15
1924	Shell Pet. Co.	Emrich #14	7:40			7:40
1926	Empire Oil & Ref.	Manning #11	43:32			43:32
1927	Mid-Continent Pet.	Motzek #6	1:15			1:15
1929	Continental Oil	Risse #13	1:50			1:50
1930	Slick Pryor & Lockhart	Habiger #B1	1:30			1:30
1932	Continental Oil	Risse #12	1:22			1:22
1936	Herndon Drg. Co.	Smith #2	7:30	1954	3:33	11:03
1938	Hinerman & Skiles	Edwards #1	2:03			2:03
1942	Yarnell-Carlson Oil	Bloomer #1	2:51			2:51
1943	W. I. Southern	Shaffer #2	2:15			2:15
1948	Texas Co.	Moran #2	1:50			1:50

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1938	Hinerman & Skiles	Edwards #1	2:03			2:03
1942	Yarnell-Carlson Oil	Bloomer #1	2:51			2:51
1943	W. I. Southern	Shaffer #2	2:15			2:15
1948	Texas Co.	Moran #2	1:50			1:50
1950	Empire Oil & Ref.	Janssen #3	8:30	1985	18:53	27:23
1955	Gulf Oil Corp.	Malone #3	7:46			7:46
1961	Stanolind Oil & Gas	Richardson #1	1:12			1:12
1968	Empire Oil & Ref.	Sifers #1	5:24	1994	18:00	23:24
1969	Sinclair	Sharp #6	4:12			4:12
1970	Phillips Pet.	Winteer #1	10:56			10:56
1971	Phillips Pet.	Bertha #1	4:24			4:24
1972	Shell Pet. Co.	Brown #1	4:04			4:04
1974	Stanolind Oil & Gas	Roesner #1	2:40			2:40
1976	Sinclair	Isern #1	3:05	1687	3:05	
				1719	2:21	8:31
1986	W. I. Southern	M. Weeks #1	2:54			2:54
1989	Phillips	Krampe #11	2:08			2:08
1990	Empire Oil & Ref.	Batman #19	14:55			14:55
1991	W. I. Southern	Sellens Heirs #2	3:22			3:22
1992	Gulf Oil Corp.	Zahorsky #2	0:15			0:15
1995	Simpson Oil Co.	Bowman #1	21:59	2013	5:05	27:04
1996	Stanolind Oil & Gas	Banning #1	2:02			2:02
1997	Empire Oil & Ref.	Boxberger #1	4:00			4:00
1998	W. I. Southern	Sellens Heirs #3	6:12			6:12
2001	Carter Oil Co.	Mollhagen #1	3:20			3:20
2014	Phillips Pet. Co.	Matzek #5	0:58			0:58
2016	Skelly Oil Co.	M. Figgins #2	17:02			17:02
2022	W. I. Southern	C. W. Shaffer #3	2:18			2:18
2024	Coralena Oil Co.	Trapp #2	1:20			1:20
2027	Sinclair Prairie	Berrick #1	29:20			29:20
2031	Coralena Oil Co.	Boomhower #2	7:57			7:57
2033	Simpson Oil Co.	Eberhart #2	31:40			31:40
2034	Stanolind Oil & Gas	O. L. Smith #3	3:20			3:20
2035	Carter Oil Co.	Ogden #5	0:47	1987	2:50	3:37
2037	Gulf Oil Corp.	Dick #4	3:38			3:38
2040	Gulf Oil Corp.	Zahorsky #1	3:32			3:32
2041	Empire Oil & Ref.	Janssen #2B	9:10			9:10
2046	Empire Oil & Ref.	Varner #27	46:15			46:15
2052	Empire Oil & Ref.	Kirkpatrick #1	9:40			9:40
2053	Coralena Oil Co.	Trapp #3	2:05			2:05
2065	Shell Pet. Corp.	Tobias #1	6:04	2080	25:23	31:27
2069	W. I. Southern	C. W. Shaffer #4	2:11			2:11
2066	Texas Co.	Anton Ruder #1	3:44	2079	4:20	8:04
2077	Shell Pet. Corp.	Sherman B#2	5:13			5:13
2081	Empire Oil & Ref.	Boyer #16	5:15			5:15
2084	Republic Nat. Gas	McLean #1	2:43			2:43
2087	Empire Oil & Ref.	Janssen #4A	33:10			33:10
2088	Republic Nat. Gas	Bloomer #1	2:45			2:45
2089	Carter Oil Co.	Teubner #7	1:35			1:35
2091	Texas Co.	Anton Ruder #1	2:11	drilled deeper since 2066		2:11
2092	Phillips Pet. Co.	S. Price #1	1:54			1:54
2093	Gulf Oil Corp.	Swires #2	1:56			1:56
2094	Coralena Oil Corp.	Trapp #4	1:28			1:28

802 hr. 3207 m.

97 Consecutive Arbuckle Dolomite Wells
Treated by Dowell in Kansas from March to

PLAINTIFF'S EXHIBIT 350

2041	Empire Oil & Ref.	Janssen #2B	9:10			9:10
2046	Empire Oil & Ref.	Varner #27	46:15			46:15
2052	Empire Oil & Ref.	Kirkpatrick #1	9:40			9:40
2053	Coralena Oil Co.	Trapp #3	2:05			2:05
2065	Shell Pet. Corp.	Tobias #1	6:04	2080	25:23	31:27
2069	W. I. Southern	C. W. Shaffer #4	2:11			2:11
2066	Texas Co.	Anton Ruder #1	3:44	2079	4:20	8:04
2077	Shell Pet. Corp.	Sherman B#2	5:13			5:13
2081	Empire Oil & Ref.	Boyer #16	5:15			5:15
2084	Republic Nat. Gas	McLean #1	2:43			2:43
2087	Empire Oil & Ref.	Janssen #4A	33:10			33:10
2088	Republic Nat. Gas	Bloomer #1	2:45			2:45
2089	Carter Oil Co.	Teubner #7	1:35			1:35
2091	Texas Co.	Anton Ruder #1	2:11	drilled deeper since 2066		2:11
2092	Phillips Pet. Co.	S. Price #1	1:54			1:54
2093	Gulf Oil Corp.	Swires #2	1:56			1:56
2094	Coralena Oil Corp.	Trapp #4	1:28			1:28

802 hr. 3207 m.

97 Consecutive Arbucle Dolomite Wells
Treated by Dowell in Kansas from March to
September 1936. Totaling 122 Treatments.

Average Gallonage = 1089.5 Gallons
Average Maximum Treating Pressure = 528 P.S.I.
Average Time Acid in Tubing = 7 hr. 1 mi.
Average internal diameter of tubing shown in these treatments = 2.66 in.
Average length of tubing shown in these treatments = 3211 ft.
Internal surface area of tubing with an Internal Diameter of 2.66 in.

$$= \frac{2.66 \times 3.1416}{12} = .692$$ Square feet per foot,

of length or 692 square feet per 1000 ft. of length.
692 x 3.211 = 2241 square feet = average internal surface of tubing in these treatments.

PLAINTIFF'S EXHIBIT 331

Average time for 122 treatments—7 hrs. 1 min.

18 treatments 12 hrs. or over—14.75% of total

35 treatments 6 hrs. or over—26.68% of total

PLAINTIFF'S EXHIBIT 337

Chart Showing Combinations Possible Under Claims of Gravell 1,678,775

The Gravell claims are of such scope as to cover the use of the metals here listed, either alone in combination with any acid regulator for the protection of iron or steel storage or transportation drums against corrosion by acids.

Acids Corrosive Iron or Steel	Common Metals Within Range Specified by Gravell	Acid Regulators Listed by Gravell—with Approximate Number of Compounds Under Each Class Indicated
Acetic	1. Antimony	1. Acid Resins—8 or More
Butyric	2. Arsenic	2. Alcohols—676 Commonly Listed, Including
Formic	3. Bismuth	3. Amyl—8 or More
Hydriodic	4. Cadmium	4. Butyl—4 or More
Hydrobromic	5. Cobalt	5. Ethyl
Hydrochloric	6. Copper	6. Methyl
Hydrofluoric	7. Lead	7. Propyl
Hydrofluosilicic	8. Nickel	8. Higher Alcohols—Large Number
Lactic	9. Thallium	9. Aldehydes—84 Commonly Listed
Monochloroacetic	10. Tin	10. Cellulose Pulp Waste—Comprises Many Different Compounds
Nitric		11. Crude Anthracene
Perchloric		12. Cyanides—91 Inorganic and 87 Organic Commonly Listed
Phosphoric		13. Distillate from Gelatine
Sulphuric		14. Distillate from Gelatine with Fats
		15. Gelatine
		16. Glycerine
		17. Hydrocarbon Tars—Many Hundreds, Number Indefinite
		18. Liquid Obtained from Bran
		19. Liquid Obtained from Starchy Material—Number Indefinite
		20. Nitrogen Ring Compounds—Many Thousands 2290 Parent Ring System and 1720 Pyrols Already Identified
		21. Organic Bases—Meaning Indefinite Over 1000 Commonly Listed
		22. Pyridine Bases—More Than 700 Commonly Listed
		23. Remains from Distillation of Anthracene
		24. Residues from Distillation of Organic Compounds—Indefinite Number—May Include Thousands
		25. Residues from Production of Naphthalene
		26. Sodium Bisulphate
		27. Sulphite Lye
		28. Sumac Leaves
		29. Waste Acids from Refining Hydrocarbons—Number and Meaning Indefinite—May Include Thousands

PLAINTIFF'S EXHIBIT 343

ALQUIST'S TABLES

Rate of Corrosion of Mild Steel in Various Concentrations of Hydrochloric Acid Solutions Containing 0.0043%, 0.102%, 1.32%, and 4.0% Copper Chloride

(Tests made at 35°C. for 16 hours)

Acid Solution	% Copper Chloride	Corrosion Rate Lbs. Lost/Sq. Ft./Day	% Corrosiveness
5% Hydrochloric Acid	0.0	0.174	100
"	0.0043	0.109	62.7
"	0.102	0.119	68.3
"	1.32	0.225	129
"	4.00	0.585	336
10% Hydrochloric Acid	0.0	0.190	100
"	0.0043	0.107	56.3
"	0.102	0.109	57.3
"	1.32	0.221	116
"	4.0	0.401	211
15% Hydrochloric Acid	0.0	0.263	100
"	0.0043	0.099	37.5
"	0.102	0.105	39.9
"	1.32	0.208	79.1
"	4.0	0.240	90.5
20% Hydrochloric Acid	0.0	0.547	100
"	0.0043	0.110	20.1
"	0.102	0.102	18.7
"	1.32	0.202	36.9
"	4.0	0.279	51.0
25% Hydrochloric Acid	0.0	1.33	100
"	0.0043	0.097	7.3
"	0.102	0.107	8.0
"	1.32	0.201	15.1
"	4.00	0.356	26.8
31.45% Hydrochloric Acid (20°Be')	0.0	1.41	100
"	0.0043	0.106	7.5
"	0.102	0.135	9.6
"	1.32	0.139	9.9
"	4.00	0.292	20.7
35% Hydrochloric Acid	0.0	0.656	100
"	0.0043	0.328	50
"	0.102	0.172	26.2
"	1.32	0.177	27.0
"	4.00	0.216	32.9

PLAINTIFF'S EXHIBIT 344

Corrosion Accelerated by the Addition of a Gravell Metal to a 31.45% Hydrochloric Acid Solution (20°Be') Containing the Acid Regulator Indicated

(Tests made at 35°C. for 16 hours)

No. on Graph	Acid	Acid Regulator	Metal	Corrosion Rate Lbs. Lost/ Sq. Ft./Day	% Corrosiveness
1	31.45% Hydrochloric Acid (20°Be')	0.1% HCl Bone Oil Extract	—	0.5834	100
2	"	"	0.228% Tin	1.189	193.2
3	"	"	0.227% Cobalt	0.979	159.3
4	"	"	0.226% Nickel	0.7338	119.3
1	"	0.5% HCl Bone Oil Extract	—	0.3277	100
2	"	"	0.228% Tin	0.3606	110.3

PLAINTIFF'S EXHIBIT 347

DOWELL INCORPORATED

WELL TREATMENTS

	1932	1933	1934	1935	1936	1937	1938	1939	1940	Total
Total Treatments	59	1,121	1,988	2,144	3,057	4,764	3,850	4,241	5,522	26,746
Deductions:										
California Treatments*	0	0	0	0	2	32	91	48	42	215
Houston District—										
Mud Acid Treatments	0	0	0	0	0	0	3	93	241	337
Dow Chemical Treatments	0	2	0	0	3	5	7	3	21	41
Truck Rentals	0	0	0	1	25	34	51	88	148	347
Stuck Drill Pipe	0	0	4	20	31	23	6	21	28	133
Packer Seal Treatments	0	0	0	0	2	4	18	8	1	33
Scale Removal, Other Than California*(Not Known for 1932-1937)	..	..	..	..	..	..	0	0	6	6
	0	2	4	21	63	98	176	261	487	1,112
Net Total	59	1,119	1,984	2,123	2,994	4,666	3,674	3,980	5,035	25,634

*Eliminated because treatments in California were not in limestone formations.

Plaintiff's Exhibit 347

1806

PLAINTIFF'S EXHIBIT 348

Treatments Made by Licensees Other Than Dowell
This report does not include treatments made by
California Licensees

Year	Number of Treatments
1934	38
1935	76
1936	256
1937	420
1938	406
1939	635
1940	446
	2,277

PLAINTIFF'S EXHIBIT 349

Summary of Royalty Charged by The Dow Chemical Co., Midland, Michigan

	1936	1937	1938	1939	1940
Quinlan Acid Service	105.00	5,008.22	4,328.67	7,241.86	6,070.98
Oil Well Cementing & Acid Corporation	537.75	2,132.03	532.06		
Morgan Acid Inc.		17,036.82	13,994.23	11,955.62	
Montana Acid Company			1,454.70	3,341.44	1,365.53
Ainsworth Well Treating Service			715.40	3,502.42	353.45
Western Incorporated				4,998.53	19,180.81
James G. Vandergrift				233.58	
Eline Acid Company					3,679.63
	642.75	24,177.07	21,025.06	31,273.45	30,650.40

Total.....$107,768.73

PLAINTIFF'S EXHIBIT 350

DOWELL INCORPORATED

Gallons of Inhibited Acid, Inhibitors and Surface Tension Reduction Agents

Year	Gallons Inhibited Acid	Gallons Inhibitors	Gallons Surface Tension Reduction Agents
Nov. 10 thru Dec. 31, 1932	84,950	155	
1933	1,220,757	6,738	
1934	2,297,254	5,249	1,622
1935	3,251,868	19,890	367
1936	7,059,407	42,339	2,781
1937	12,492,420	78,627	11,804
1938	10,170,863	42,641	12,897
1939	10,892,434	51,712	28,434
1940	15,113,754	77,249	48,585
	62,583,707	324,600	106,490

NOTE: Above figures form the basis for accompanying chart.

PLAINTIFF'S EXHIBIT 351

HALLIBURTON OIL WELL CEMENTING COMPANY
Acidizing Order and Data

8-2-1938

Owner Weber Oil Co.
Name of well Stella Wilcox #3 Invoicing Address Bay City Bank Bldg., Bay City, Michigan.
Sec. 34, Twp. 22 N. Range 2 E.

We authorize you to furnish 750 (Pen) gal. acid, other necessary materials equipment and to assist us in placing same in above well on 8-2-1938 at 9: A.M.

Preliminary Data

Casing size 5½" Weight 14# Set at 2487' Cemented Yes
Tubing size 2" Perforations at 2638' Packer at 2492'
Formation Dundee Lime Pay 2482' 2648 streaked
T.D. 2648'
Amt. cleaned out — Theo. vol. of well 58 bbls. Bleeding —
Date Brought in 7-23-1938
I. P. Oil 10 bbls. approx.
Water in Well None Previous treatments No
Application of present treatment—Fill hole above packer and treat below packer—two stages (250 & 500)

Since it is necessary in work of this nature to depend largely on indicated conditions in a well, and there being natural uncertainties as to measurements and variations in the formations to be treated, it is expressly agreed:

(a) That Halliburton Oil Well Cementing Company makes no guarantee of the effectiveness of the materials to be used in the treatment of the well, nor of the results of the treatment.

(b) That it shall not be liable for any injury or damage to the well growing out of or resulting from the treatment of said well, or from the use of said equipment in doing said work.

(c) That Halliburton Oil Well Cementing Company only agrees to furnish the materials herein ordered and its equipment suitable for placing said materials in said well and two operators to assist in performing the work under the supervision of the owner of the well or his representative.

Weber Oil Co.
By W. L. Steelman

HALLIBURTON OIL WELL CEMENTING COMPANY
Acidizing Ticket

No. 8184 AT

Charge To Weber Oil Co. Date 8-2-1938

Mail Address Bay City Bank Bldg., Bay City, Michigan

Lease Stella Wilcox 3 Sec. 34 Twp. 22 N R. 2 E State Mich.

County or Pool Ogemaw Arrival 8:00 A.M. Howco Trucks No. 599

Gallonage Hired Trucks — Miles to Well 87

Oil Used Filling Well One bbl. Water removed before treatment None

How many pumps used One Time acid on bottom —

Pressure Records

Time	Vol. Acid In	Pressure Casing	Pressure Tubing
1st			
10:00 A.M.	Start	200#	0
10:05 A.M.	250 Gal	200	0
10:10 A.M.	350 Gal	150#	600#
10:25 A.M.	12 bbls. oil	150#	800#
2nd			
2:00 P.M.	Start	150#	0
2:05 P.M.	500 Gal.	150#	0
2:15 P.M.	10 bbls.	200#	200#
2:30 P.M.	18 bbls.	200#	800#

Flushing Oil Used:
1st 12 bbls 2nd 18 bbls. Pressure at end. Casing 1st 150# 2nd 200
Tubing 1st 800# 2nd 800#
Materials Used 750 gal. (Pen) Acid — 10 gal. blanket
Charges: Acid $172.50 Blanket — Total $172.50

The above job was done under the supervision of the owner, operator or his agent whose signature appears below:
Treater: (Signed) Carl A. Nicholas Owner of Well or Agent
Helper: W. G. Aspin W. L. Steelman
District: Michigan
The following information is urgently requested in order that we may be fully advised and to enable us to keep our standard of service up to the highest point:
Was the work of Acidizing Equipment satisfactory? Yes
Was the work of Acidizing Crew performed in a satisfactory manner? Yes.
Was the Acidizing job satisfactorily completed? Yes.
Owner of Well or Agent
W. L. Steelman

HALLIBURTON OIL WELL CEMENTING COMPANY

Acidizing Order and Data

Date 8-5-1938

Owner Weber Oil Co.
Name of Well Stella Wilcox # 3 Invoicing Address Bay City Bank Bldg., Bay City, Michigan.
Sec. 34 Twp. 22N Range 2 E.

We authorize you to furnish 2000 (Penetrating) gal. acid, other necessary materials equipment and to assist us in placing same in above well on 8-5-1938 (Date) at 9:30 A.M. (time).

Plaintiff's Exhibit 351

Preliminary Data

Casing size 5½" Weight 14# Set at 2487' Cemented Yes
Tubing size 2" Perforations at 2638' Packer at 2492'
Formation Dundee Lime Pay 2492' to 2638' Streaked.
T.D. 2648' P.B. No. Shot No
Amt. cleaned out — Theo. vol. of well 58 bbls. Bleeding —
Date brought in 7-23-1938
I.P. Oil 10 bbls per day Water — Gas —
P.P. Oil 40 bbls. " " Water — Gas —
Water in well None Previous treatments 8-2-1938
By H.O.W.C. Co.
two stages 250 & 500
Howco No. 8184 Materials used 750 gal. Acid. Time treating 55 min.
Max. pressures encountered 800#
Results: increased from 10 bbls. to 40 bbls. per day.
Application of present treatment: fill hole above packer & treat below packer

Since it is necessary in work of this nature to depend largely on indicated conditions in a well, and there being natural uncertainties as to measurements and variations in the formations to be treated, it is expressly agreed:

(a) That Halliburton Oil Well Cementing Company makes no guarantee of the effectiveness of the materials to be used in the treatment of the well, nor of the results of the treatment.

(b) That it shall not be liable for any injury or damage to the well growing out of or resulting from the treatment of said well, or from the use of said equipment in doing said work.

(c) That Halliburton Oil Well Cementing Company only agrees to furnish the materials herein ordered and its equipment suitable for placing said materials in said well and two operators to assist in performing the work under the supervision of the owner of the well or his representative.

Weber Oil Co.,
By W. L. Steelman

Plaintiff's Exhibit 351

HALLIBURTON OIL WELL CEMENTING COMPANY
ACIDIZING TICKET

No. 8185 AT

Charge To Weber Oil Co. **Date 8-5-1938**
Mail Address Bay City Bank Bldg., Bay City, Mich.
Lease Stella Wilcox Well 3 Sec. 34 Twp. 22N R.2E State Mich.
County or Pool Ogemaw Arrival 8:20 A.M. Howco Trucks No. 599

Trailers No. 54 Miles to Well 87
Oil used filling well None Water removed before treatment None
How many pumps used One Time acid on bottom 9:35 A.M.

Pressure Records

Time	Vol. Acid in	Pressure Casing	Pressure Tubing
9:30 A.M.	Start	0	0
9:35 A.M.	500 gal.	50#	15
9:40 A.M.	1000	100#	15
9:42 A.M.	1200	100#	100#
9:55 A.M.	2000	100#	400#
10:30 A.M.	15 bbls. oil	50#	700#
11:00 A.M.	25 " "	0	600#

Flushing oil used 25 bbls. pressure at end. Casing 0 Tubing 600#
Materials used 2000 gal. (Pen) Acid & 30 gal. blanket
Charges: Acid $350.00 Blanket — Total $350.00

The above job was done under the supervision of the owner, operator or his agent whose signature appears below:
Treater: Owner of Well or Agent:
Carl A. Nicholas W. L. Steelman
Helper: Aspin & Campbell District Michigan
The following information is urgently requested in order that we may be fully advised and to enable us to keep our standard of service up to the highest point:

Plaintiff's Exhibit 351

Was the work of Acidizing Equipment satisfactory? Yes.
Was the work of Acidizing Crew performed in a satisfactory manner? Yes.
Was the Acidizing job satisfactorily completed? Yes.

W. L. Steelman
Owner of Well or Agent.

HALLIBURTON OIL WELL CEMENTING COMPANY
ACIDIZING ORDER AND DATA

Date 8-19-1938

Owner Weber Oil Co.
Name of well R. Zahn #2 Invoicing Address: Bay City Bank Bldg., Bay City, Michigan
Sec. 34 Twp. 22 N. Range 2 E.

We authorize you to furnish 2000 (Pen) gal. acid, other necessary materials equipment and to assist us in placing same in above well on 8-19-1938 (Date) at 9:00 A.M. (time).

Preliminary Data

Casing size 5½ Weight 14# Set at 2532' Cemented Yes
Tubing size 2" Perforations at 2665' Packer at 2538'
Formation Dundee Lime Pay 2550 to 2674 streaks
T.D. 2674 P.B. Yes Shot No
Amt. cleaned out — Theo. vol. of well 52 bbls Bleeding —
I.P. Oil 4 bbls. per day Water 5 gal. per day Gas
Source of water Pay Nearness to water —
Water in well Very little Previous treatments No
Howco No. — Materials used Time treating
Max. pressures encountered
Results
Application of present treatment: Load hole above packer and treat in three stages 250 — 500 & 1250 gal. Swab well after each treatment.

Since it is necessary in work of this nature to depend largely on indicated conditions in a well, and there being natural uncertainties as to measurements and variations in the formations to be treated, it is expressly agreed:

(a) That Halliburton Oil Well Cementing Company makes no guarantee of the effectiveness of the materials to be used in the treatment of the well, nor of the results of the treatment.

(b) That it shall not be liable for any injury or damage to the well growing out of or resulting from the treatment of said well, or from the use of said equipment in doing said work.

(c) That Halliburton Oil Well Cementing Company only agrees to furnish the materials herein ordered and its equipment suitable for placing said materials in said well and two operators to assist in performing the work under the supervision of the owner of the well or his representative.

Weber Oil Co.
By W. L. Steelman

HALLIBURTON OIL WELL CEMENTING COMPANY
Acidizing Ticket

No. 8188 AT

Charge to Weber Oil Co. Date: 8-19-1938
Mail Address Bay City Bank Bldg., Bay City, Mich.
Lease R. Zahn Well 2 Sec. 34 Twp. 22N R. 2E State Mich
County or Pool Ogemaw Arrival 8:30 A.M. Howco Trucks No. 614
Trailers No. 57 Hired Transport Trucks—Firm name —
Gallonage Hired Trucks — Miles to Well 85
Oil used filling well — Water removed before treatment 5 gal.
How many pumps used One Time acid on bottom 1st (not legible)
2nd 2:34 P.
3rd 6:35 P.

Plaintiff's Exhibit 351

Pressure Records

Time	Vol. Acid in	Pressure Casing	Pressure Tubing
1st			
11:00 A.M.	Start	0	0
11:03 A.M.	250 gal.	25#	20
11:07 A.M.	5 bbls. oil	50#	500#
11:38 A.M.	11 bbls. oil	50#	500#
2nd			
2:30 P.M.	Start	25#	0
2:35 P.M.	500 gal.	50#	20
2:40 P.M.	8 bbls. oil	60#	300#
3:05 P.M.	16 bbls. oil	20#	600#
3rd			
6:30 P.M.	Start	50#	0
6:40 P.M.	909 gal.	100#	200#
7:00 P.M.	1250 gal.	100#	500#
8:45 P.M.	20 bbls. oil	0#	700#

Flushing Oil Used: 1st 11 bbls. 2nd 16 bbls. 3rd 20 bbls. pressure at end:
Casing 1st 50#, 2nd 20# 3rd 0 Tubing 1st 500#, 2nd 600# 3rd 700#.
Materials used 2000 gal. (Pen) acid 20 gal. blanket
Charges: Acid $350.00 Blanket $ — Total $350.00

The above job was done under the supervision of the owner, operator or his agent whose signature appears below:

Owner of Well or Agent
(Signed) W. L. Steelman

Treater:
Carl A. Nicholas (Anthony) District
Helper: Michigan
Campbell — (Swain)
The following information is urgently requested in order that we may be fully advised and to enable us to keep our standard of service up to the highest point:

Was the work of Acidizing Equipment satisfactory? Yes
Was the work of Acidizing Crew performed in a satisfactory manner? Yes
Was the Acidizing job satisfactorily completed Yes.

W. L. Steelman
Owner of Well or Agent.

HALLIBURTON OIL WELL CEMENTING COMPANY
Acidizing Order and Data

Date 9-10-1938

Owner Weber Oil Co.
Name of well Crawford #5 Invoicing Address Bay City Bank Bldg., Bay City, Michigan
Sec. 28 Twp. 22 N Range 2 E

We authorize you to furnish 2,000 (Klersol) gal. acid, other necessary materials equipment and to assist us in placing same in above well on 9-10-1938 (date) at 9:00 A.M. (time).

Preliminary Data

Casing size 5½ Weight 14# Set at 2557 Cemented Yes
Tubing size 2" Perforations at 2715' Packer at —
Formation Dundee Lime Pay 2567 to 2715 (Streaks)
T.D. 2724 P.B. No Shot No
Amt. cleaned out — Theo. vol. of well 57 bbls. Bleeding 560
Date brought in 9-7-1938.
I. P. Oil 10 bbls. per day Water — Gas —
P. P. Oil " " " " Water — Gas —
Source of water — Nearness to water —
Water in well None Previous treatments — (dated)
Howco No. — Materials used Time treating
Max. pressures encountered
Results
Application of present treatment — fill hole and treat thru tubing.

Since it is necessary in work of this nature to depend largely on indicated conditions in a well, and there being natural uncertainties as to measurements and variations in the formations to be treated, it is expressly agreed:

(a) That Halliburton Oil Well Cementing Company makes no guarantee of the effectiveness of the materials to be used in the treatment of the well, nor of the results of the treatment.

(b) That it shall not be liable for any injury or damage to the well growing out of or resulting from the treatment of said well, or from the use of said equipment in doing said work.

(c) That Halliburton Oil Well Cementing Company only agrees to furnish the materials herein ordered and its equipment suitable for placing said materials in said well and two operators to assist in performing the work under the supervision of the owner of the well or his representative.

Weber Oil Co.
By W. L. Steelman

HALLIBURTON OIL WELL CEMENTING COMPANY
ACIDIZING TICKET

No. 8196 AT

Charge to Weber Oil Co. Date 9-10-1938

Mail Address Bay City Bank Bldg., Bay City, Michigan

Lease Crawford Well 5 Sec. 28 Twp. 22 N. R 2 E. State Michigan

County or Pool Ogemaw Arrival 10:00 A.M. Howco Trucks No. 614

Trailers No. 57 Hired Transport Trucks — Firm Name — Gallonage hired trucks — Miles to well 86

Oil used filling well 41 bbls. Water removed before treatment none

How many pumps used One. Time acid on bottom 12.25 P.M.

Pressure Records

Time	Vol. Acid In	Pressure Casing	Pressure Tubing
12:20 P.M.	Start	0	0
12:30 P.M.	600 gal.	700	350
1:10 P.M.	1000 "	800	475
1:55 P.M.	1500 "	700	375
2:45 P.M.	2000 "	700	375
3:30 P.M.	15 bbls. oil	700	700

Flushing oil used 15 bbls. pressure at end: Casing 700#
Tubing 700#
Materials used 2000 gal. (Klersol) acid & 10 gal. blanket
Charges: Acid $350.00 Blanket $ — Total $350.00

The above job was done under the supervision of the owner, operator or his agent whose signature appears below:

Treater (Signed) W. L. Steelman
Carl A. Nicholas
Helper District
Noel M. Campbell Mt. Pleasant, Michigan

The following information is urgently requested in order that we may be fully advised and to enable us to keep our standard of service up to the highest point:

Was the work of Acidizing Equipment satisfactory? Yes
Was the work of Acidizing Crew performed in a satisfactory manner? Yes.
Was the Acidizing job satisfactorily completed? Yes

W. L. Steelman
Owner of Well or Agent

HALLIBURTON OIL WELL CEMENTING COMPANY
Acidizing Order and Data

Date 4-24-1939

Owner Petroleum Investors Inc.
Name of well Knight Invoicing Address
Sec. 16 Twp. 18 N Range 1 E

We authorize you to furnish 1500 gal. Pen. gal. acid, other necessary materials equipment and to assist us in placing same in above well on 4-24-1939 (date) at 2:00 P.M. (time).

Preliminary Data

Casing size 5½ O.D. Weight 17# Set at 3569 Cemented Yes
Liner size — Length — Set at — Cemented —
Tubing size 2" up Jet Perforations at 3624 Packer at —
Formation Dundee Pay Lime

Plaintiff's Exhibit 351

T.D. 3628 P. B. — Shot —
Amt. cleaned out — Theo. vol. of well 78 bbl. Bleeding 605
Date brought in 2-15-1939
I.P. Oil 16 bbls. Water No Gas —
P.P. oil 7 bbls. Water 23 bbl. Gas —
Source of water Bottom Hole Nearness to water 2 ft.
Water in well — Previous treatments (date)
Howco No. Materials used Time treating
Max. pressures encountered
Results
Application of present treatment

Since it is necessary in work of this nature to depend largely on indicated conditions in a well, and there being natural uncertainties as to measurements and variations in the formations to be treated, it is expressly agreed:

(a) That Halliburton Oil Well Cementing Company makes no guarantee of the effectiveness of the materials to be used in the treatment of the well, nor of the results of the treatment.

(b) That it shall not be liable for any injury or damage to the well growing out of or resulting from the treatment of said well, or from the use of said equipment in doing said work.

(c) That Halliburton Oil Well Cementing Company only agrees to furnish the materials herein ordered and its equipment suitable for placing said materials in said well and two operators to assist in performing the work under the supervision of the owner of the well or his representative.

Name of Company Ordering Materials and Equipment

.....

(Signed) William Brown

Plaintiff's Exhibit 351

HALLIBURTON OIL WELL CEMENTING COMPANY
Acidizing Ticket

No. 8352 AT

Charge to Petroleum Investors Inc. Date 4-24-1939
Mail Address Mt. Pleasant, Mich.
Lease Knight Well 2 Sec. 16 Twp. 18 N R. 1E State Mich.
County or Pool — Arrival 2:00 P.M. Howco Trucks No. 669-473
Trailers No. 36 — 57 Hired Transport Trucks — Firm Name —
Gallonage Hired Trucks — Miles to Well 55 Miles
Oil used filling well 85 bbls. Water removed before treatment —
How many pumps used One Time acid on bottom 5:12 P.M.

Pressure Records

Time	Vol. Acid in	Pressure Casing	Tubing
Start 5:00 P.M.		30V	30V
5:05 P.M.	500 gal.	30V	30V
5:10 P.M.	1000 gal.	30V	30V
5:15 P.M.	1500 gal.	30V	30V
5:30	16 bbl.	30V	30V

L. G. King

Flushing Oil used 588 gal. pressure at end. Casing 30 V. Tubing 30 V.

Materials used 1500 Gal. Penn
Charges: Acid $270.00 Blanket 3 gal. Total $270.00

The above job was done under the supervision of the owner, operator or his agent whose signature appears below:

Treater
L. G. King

Owner of Well or Agent
William F. Brown

Helper
D. J. Sargent

District
Eastern Mich.

Plaintiff's Exhibit 351

The following information is urgently requested in order that we may be fully advised and to enable us to keep our standard of service up to the highest point:

Was the work of Acidizing Equipment satisfactory?

Was the work of Acidizing Crew performed in a satisfactory manner?

Was the Acidizing job satisfactorily completed?

Suggestions:

Petroleum Inv. Inc.
William F. Brown
Owner of Well or Agent

PLAINTIFF'S EXHIBIT 354

DOWELL ADVERTISING
FOR THE YEAR, 1932

Date	Vendor	Invoice	Amount	Tot
Sept. 1	Mich. Oil Journal	August Ads	$18.00*	$ 18
Oct. 1	Mich. Oil Journal	September Ads	24.00*	24
	November			
	Mich. Oil Journal	October Ads	$18.00*	
Nov. 10	The Fred M. Randall Co.	36889	456.55*	
" 10	" " " " "	36891	6.98*	
" 25	" " " " "	36922	684.25	
" 30	" " " " "	37005	841.80	
" 30	" " " " "	37038	11.50	
" 30	" " " " "	37010	78.78	
" 30	" " " " "	37011	116.73	
" 30	" " " " "	37053	43.89	
" 30	" " " " "	37013	32.82	
" 29	" " " " "	36968	99.56	
" 29	" " " " "	36969	43.82	$2,434
	December			
Dec. 1	Mich. Oil Journal	November Ads	24.00	
" 31	The Fred M. Randall Co.	37330	380.00	
" 31	" " " " "	37336	300.00	
" 31	" " " " "	37349	21.94	
" 31	" " " " "	37353	27.60	
" 23	" " " " "	37210	15.32	
" 23	" " " " "	37211	21.28	$ 790
	*Paid by The Dow Chemical Company		$523.53	
	Paid by Dowell Incorporated		2,743.29	$3,266

Plaintiff's Exhibit 354

DOWELL INCORPORATED
ADVERTISING

1933

January	$ 88.11
February	853.64
March	201.64
April	1,266.72
May	276.14
June	10.08
July	243.54
August	205.63
September	357.11
October	286.69
November	368.67
December	385.12
	$4,543.09

1934

January	
February	$ 27.50
March	10.50
April	112.76
May	1,609.13
June.	677.04
July	327.65
August	478.16
September	441.40
October	378.52
November	1,059.55
December	3,321.87
	$8,444.08

PLAINTIFF'S EXHIBIT 355

Failure Time of ½ Gallon Black Iron Drums Containing 15% Sulfuric Acid Solution with a Metal Salt or a Metal Salt and an Acid Regulator

No. on Graph	Drum Number	Acid Solution	Metal Salt	Acid Regulator	Failure Time (Hours) Actual	Average
1	1/2—136	30.6% Ortho-	—	—	47	
	1/2—137	Phosphoric Acid	—	—	73.5	
	1/2—92	"	—	—	75	
	1/2—91	"	—	—	150	
	1/2—94	"	—	—	246.5	
	1/2—89	"	—	—	292.5	
	1/2—93	"	—	—	510.5	
	1/2—90	"	—	—	696	261.4
2	1/2—179	Hydrochloric Acid Bone Oil Extract			998.7	
	1/2—178	"			1152.8	
	1/2—177	"			1317.5	
	1/2—176	"			1336.3	1201.3
3	1/2—37	93.19% Sulfuric Acid	—	—	2796	
	1/2—36	"	—	—	3027	
	1/2—38	"	—	—	3027	2950
4	1/2—154	15% Sulfuric Acid	0.1% Cadmium Sulfate	0.1% Methanol	18	
	1/2—155	"	"	"	18	18
5	1/2—221	"	0.5% Copper Sulfate	0.1% n-Butanol	17	
	1/2—220	"	"	"	25.5	21.3
6	1/2—152	"	0.1% Cadmium Sulfate	—	26	
	1/2—153	"	"	—	44.5	35.3
7	1/2—150	"	1.0% Cadmium Sulfate	0.1% Dimethyl Amine	42.5	
	1/2—151	"	"	"	42.5	42.5
8	1/2—148	"	1.0% Cadmium Sulfate	—	42.5	
	1/2—149	"	"	—	42.5	42.5
9	1/2—49	"	—	—	21.5	
	1/2—147	"	—	—	22.5	
	1/2—53	"	—	—	33.1	
	1/2—50	"	—	—	36.4	
	1/2—54	"	—	—	40.0	
	1/2—146	"	—	—	56	
	1/2—81	"	—	—	130	
	1/2—52	"	—	—	242.1	
	1/2—51	"	—	—	242.3	
	1/2—82	"	—	—	243	106.1
10	1/2—65	"	0.0043% Arsenous Oxide	0.0057% Gelatine	97.5	
	1/2—66	"	"	Distillate	207.5	152 5
11	1/2—88	"	0.1% Bismuth Oxide	0.1% Rosin	114.5	
	1/2—87	"	"	"	279.5	197
12	1/2—86	"	0.1% Nickel Sulfate	0.1% Glycerine	193	
	1/2—85	"	"	"	210	201.5
13	1/2—84	"	0.5% Copper Sulfate	—	196.5	
	1/2—83	"	"	—	329.5	263
14	1/2—183	"	0.167% Arsenous Oxide	0.1% Sulfuric Acid	234.6	
	1/2—182	"	"	Bone Oil Extract	306.6	270.6

Plaintiff's Exhibit 355

1626

PLAINTIFF'S EXHIBIT 356

10 Gallon Drum Corrosion Tests with Raw 20°Be' Hydrochloric Acid

No Metal Added. Nc Acid Regulator Added

No. on Graph	Drum Number	Hours Until Failure	Maximum Pressure Lbs./ Sq. in.	Type of Failure	Time-Pressure Graph Number	Photo-graph Number	Average Failure Time Hours
	10-68	0.75	38	Leak in bottom seam	C-1545A	—	
	10-73	1.0	60	Head blew out	C-1550A	76729	
	10-16	1.1	25	Leak at bung	—	—	
3							1.75
	10-14	1.33	38	Leak at bung	—	—	
	10-17	1.8	20	Leak at bung	—	—	
	10-15	2.67	25	Head blew out	C-1505A	76399	
	10-7	3.6	—	Head blew out	—	76402	

15 Gallon Drum Corrosion Tests with 20° Be' Hydrochloric Acid — Metals and Acid Regulators

No. on Graph	Drum Number	Metal	Acid Regulator	Hours Until Failure	Maximum Pressure Lbs./ Sq. in.	Type of Failure	Time-Pressure Graph Number	Photo-graph Number
6	10-65	0.21% Cobalt	0.5% n-Butanol	2.0	62	Leak in bottom seam	C-1542A	—
5	10-64	0.23% Cobalt	"	2.0	66	Leak in bottom seam	C-1541A	—
14	10-92	1.05% Tin	0.3% Gelatine	5.2) 5.35	52	Head blew out	C-1596A	76924
	10-91	"	"	5.5)	57	Leak in bottom seam	C-1595A	76923
18	10-78	0.22% Nickel	0.1% HCl Bone Oil Extract	11.6	55	Leak in bottom seam	C-1553A	—
19	10-79	0.24% Tin	"	12	53	Leak in bottom seam	C-1554A	—
20	10-77	0.16% Cobalt	"	16	57	Leak in bottom seam	C-1552A	—
21	10-83	0.21% Tin	"	17.4	64	Head blew out	C-1558A	76731
23	10-84	0.24% Tin	0.5% "	24.6	55	Leak in bottom seam	C-1559A	—
24	10-85	0.27% Cobalt	0.1% "	25.5	60	Head blew out	C-1560A	76732
25	10-90	1.14% Tin	2.5% Vol. Monoethyl Amine 22.5% Vol. Diethyl Amine	29.75	63	Leak in bottom seam	C-1594A	76922
26	10-89	0.48% Tin	0.5% HCl Bone Oil Extract	32.3	55	Leak in bottom seam	C-1593A	76921
27	10-76	0.20% Cobalt	"	32.4	56	Leak in bottom seam	C-1551A	—
32	10-63	0.26% Arsenic	0.0057% Gelatine Distillate	563.2	54	Blew out	C-1604A	—
33	10-62	0.30% Arsenic	"	667.4	46	Leak in bottom seam	C-1603A	—
31*	10-108	1.32% Arsenous Oxide	25% Vol. Barrett Comm. Pyridine No. 2	Not Completed:		Started 7-2-41, 9:45 p.m.		
	10-109	"	"			Started 7-2-41, 10:35 p.m.		

* Corresponds to Composition B of the patent.

10-Gallon Drum Corrosion Tests with 30% Ortho-Phosphoric Acid Solution With or Without a Metal and/or an Acid Regulator

No. on Graph	Drum Number	Metal	Acid Regulator	Hours Until Failure	Maximum Pressure Lbs./ Sq. in.	Type of Failure	Time-Pressure Graph Number	Photo-graph Number	Average Failure Time Hours
1	10-71	—	—	21.75	47.2	Leak in bottom seam	C-1548A	—	35.4
	10-40	—	—	22.7	41	"	C-1525A	—	
	10-72	—	—	25	50	"	C-1549A	—	
	10-38	—	—	27.5	41	"	C-1523A	—	
	10-34	—	—	38.7	39	Leak	C-1519A	—	
	10-33	—	—	39.8	45	"	C-1518A	—	
	10-37	—	—	40.1	40	Leak in bottom seam	C-1522A	—	
	10-39	—	—	40.8	32	"	C-1524A	—	
	10-35	—	—	42.6	35	Leak	C-1520A	—	
	10-36	—	—	55.3	30	Leak	C-1521A	—	
2	10-50	0.52% Nickel	—	20.75	56	Leak in bottom seam	C-1533A	76694	20.75
3	10-49	0.51% Nickel	—	22.1	51.5	Leak in bottom seam	C-1532A	76693	22.1
4	10-29	0.145% Copper	—	23.9	35	Bottom blew out	C-1514A	76489	27.3
	10-30	0.145% Copper	—	30.75	32	Leak in bottom seam	C-1515A	—	
5	10-31	0.160% Nickel	—	33.1	55	Leak in bottom seam	C-1516A	76493	33.1
6	10-32	0.175% Nickel	—	57.9	53	Leak in bottom seam	C-1517A	—	57.9
7	10-104	0.102% Arsenic	0.053% Pyridine Base Mix. (Interlake)	233.5	17.5	Leak in bottom seam	C-1641A	—	259.6
	10-103	"	"	285.8	14.5	"	C-1642A	—	
8	10-52	0.19% Arsenic	—	948	9.0	Leak in bottom seam	C-1602A	—	793.9
	10-51	"	—	639.8	14.5	Bottom blew out	C-1601A	—	

Note: This table does not include arsenic treated drums.

PLAINTIFF'S EXHIBIT 356

FAILURE TIME OF ICC 5A 10-GALLON DRUMS CONTAINING 20°Be′ HYDROCHLORIC ACID SOLUTION AND A METAL OR A METAL AND AN ACID REGULATOR

No. on Graph	Acid Solution	Metal	Acid Regulator	Failure Time Hours
1	30% Ortho-Phosphoric Acid	—	—	35.4 (Average of 10)
2	95.5% Sulfuric Acid	—	—	Tests not Completed Started 9:00 a.m. 9:30 a.m. 4-30-41
3	20°Be′ Hydrochloric Acid	—	—	1.75 (Average of 7)
4	"	—	0.5% n-Butanol	1.0
5	"	0.23% Cobalt	"	2.0
6	"	0.21% Cobalt	"	2.0
7	"	0.23% Mercury	—	2.0
8	"	0.19% Mercury	—	2.4
9	"	0.13% Nickel	—	3.1
10	"	0.306% Bismuth	—	4.8
11	"	0.125% Nickel	—	5.25
12	"	0.118% Nickel	—	5.3
13	"	0.315% Bismuth	—	5.3
14	"	1.05% Tin	0.3% Gelatine	5.35 (Average of 2)
15	"	0.330% Bismuth	—	7.75
16	"	0.303% Bismuth	—	8.0
17	"	0.115% Nickel	—	9.5
18	"	0.22% Nickel	0.1% Hydrochloric Acid Bone Oil Extract	11.6
19	"	0.24% Tin	"	12.0
20	"	0.16% Cobalt	"	16.0
21	"	0.21% Tin	"	17.4
22	"	—	"	20.2 (Average of 2)
23	"	0.24% Tin	0.5% Hydrochloric Acid Bone Oil Extract	24.6
24	"	0.27% Cobalt	0.1% Hydrochloric Acid Bone Oil Extract	25.5
25	"	1.14% Tin	2.5% Volume Monoethyl Amine 22.5% Volume Diethyl Amine	29.75
26	"	0.48% Tin	0.5% Hydrochloric Acid Bone Oil Extract	32.3
27	"	0.20% Cobalt	"	32.4

Plaintiff's Exhibit 356

			Bone Oil Extract	11.6
19	"	0.24% Tin	"	12.0
20	"	0.16% Cobalt	"	16.0
21	"	0.21% Tin	"	17.4
22	"	—	"	20.2 (Average of 2)
23	"	0.24% Tin	0.5% Hydrochloric Acid Bone Oil Extract	24.6
24	"	0.27% Cobalt	0.1% Hydrochloric Acid Bone Oil Extract	25.5
25	"	1.14% Tin	2.5% Volume Monoethyl Amine 22.5% Volume Diethyl Amine	29.75
26	"	0.48% Tin	0.5% Hydrochloric Acid Bone Oil Extract	32.3
27	"	0.20% Cobalt	"	32.4
28	"	—	"	37.57 (Average of 2)
29	"	0.229% Antimony	—	47.25
30	"	0.269% Antimony	—	59.5
31[x]	"	1.32% Arsenous Oxide	25% Volume Barrett Commercial Pyridine No. 2	Tests not Completed Started 9:45 p.m. 10:35 p.m. 7-2-41
32	"	0.26% Arsenic	0.0057% Gelatine Distillate	563.2 hrs.
33	"	0.30% Arsenic	0.0057% Gelatine Distillate	667.4

[x]Corresponds to Composition B of the patent.

PLAINTIFF'S EXHIBIT 356

Failure Time of ICC 5E and ICC 5A 55-Gallon Drums Containing Hydrochloric Acid Solution With or Without a Metal or an Acid Regulator

No. on Graph	Drum No.	Acid Solution		Metal Salt	Acid Regulator	Failure Time Hours	Maximum Pressure
				ICC 5E Drum Tests			
1	1	22.5%	Hydrochloric Acid Solution	—	—	20	17
2	2	25 %	"	0.159% Arsenous Oxide	—	59.5	16
3	6	24.9%	"	—	0.4% Pyridine Bases[x]	132.5	23
4	3	25 %	"	0.185% Arsenous Oxide	"	255.5	18.5
5	4	25 %	"	0.753% Arsenous Oxide	1.0% Gelatine	471.5	14
				ICC 5A Drum Tests			
1	13	25.2%	"	0.19% Arsenous Oxide	—	44.5	24
2	14	23.5%	"	—	—	165.5	73
3	10	22.3%	"	—	0.4% Pyridine Bases[x]	429	8–¼
4	9	23.3%	"	0.765% Arsenous Oxide	1.0% Gelatine	479	31
5	11	22.2%	"	0.217% Arsenous Oxide	0.4% Pyridine Bases[x]	573	30

[x]Barrett Pickling Compound No. 93

PLAINTIFF'S EXHIBIT 357

ANALYSIS OF ACID SOLUTIONS OF TESTS No. 3 and 7

Hours from Start	Test No. 3 Atmospheric Pressure 43°C. (110°F.) % Hydrochloric Acid	Test No. 3 % Fe	Test No. 7 Atmospheric Pressure 30°C. (86°F.) % Hydrochloric Acid	Test No. 7 % Fe
0	15.0	0.0	15.0	0.0
3	10.83	2.91	13.6	1.41
6	8.63	4.37	12.6	1.96
9	6.89	5.59	11.6	2.73
12	4.95	6.91	10.3	3.45
15	3.15	8.13	9.5	3.97
18	1.86	9.03	8.2	4.66
21	0.47	10.05	7.4	5.14
24	0.012	10.29	6.1	5.99

SUMMARY OF TESTS

Test No.	1	3	8	7
Time of Test	21.75 hours	24 hours	24 hours	24 hours
Temperature Maintained	43°C.	43°C.	30°C.	30°C.
Maximum	48°C.	46°C.	33°C.	33°C.
Minimum	40°C.	40°C.	28°C.	28°C.
Pressure Maintained, Lbs./sq. in.	1000	Atmospheric	1000	Atmospheric
Maximum	1080	—	1060	—
Minimum	980	—	960	—
Analysis of Solution After Test				
% Hydrochloric Acid	0.014	0.012	4.6	6.1
% Iron	10.62	10.29	7.04	5.99
Samples Taken	At end of run.	Every 3 hrs.	At end of run.	Every 3 hours.

PLAINTIFF'S EXHIBIT 358

Summary of acid corrosion tests of 15.1% commercial hydrochloric acids using metal strips of strap iron

Commercial Hydrochloric Acid	% Reduction in Corrosiveness		
	Strap iron Series N	Strap iron Series O	Average
American Cyanamid and Chemical Corp.	1	....	1
Bay Chemical Co., Inc.	—14	—17	—15.5
Central Chemical Sample 1	5	....	5
Central Chemical Sample 2	4	....	4
Consolidated Chemical Industries, Inc., Fort Worth, Texas	11	....	11
Consolidated Chemical Industries, Inc., Houston, Texas	0	....	0
Detroit Chemical Works	3	....	3
Dow Chemical Co., San Francisco, Calif.	—8	—1	—4.5
Dow Chemical Co., Sample 1	....	4	4
Dow Chemical Co.. Sample 2	....	8	8
General Chemical Co.	3	....	3
Hooker Electrochemical Co.	0.8	....	0.8
Monsanto Chemical Co., Sample 1	6	....	6
Monsanto Chemical Co., Sample 2	0.5	....	0.5
Ozark Chemical Co.	—12	—4	—8
Pennsylvania Salt Mfg. Co.	2	....	2
Southern Acid & Sulphur Co., Inc.	—12	—5	—8.5
Stauffer Chemical Co., Sample 1	3	....	3
Stauffer Chemical Co., Sample 2	8	....	8

The average reduction in corrosiveness of the above 19 acid samples is 1.2%.

The average reduction in corrosiveness of the acids from the 13 different companies is —0.1%.

PLAINTIFF'S EXHIBIT 360

Dowell Incorporated

ADVERTISING

Year	Amount	Number Paid Treatments Using Grebe-Sanford Method
1932*	$ 3,266.82	236
1933	4,543.09	1,119
1934	8,444.08	1,984
1935	19,371.05	2,123
1936	16,784.67	2,994
1937	22,871.06	4,666
1938	35,358.59	3,674
1939	35,897.22	3,980
1940	53,324.98	5,035

*Figures are for Dow and Dowell

PLAINTIFF'S EXHIBIT 362

Physical Laboratory
THE DOW CHEMICAL COMPANY

File No. 0109

From J. J. Grebe. By N. Poffenberger.
Date Rec'd, Aug. 18, 1930. Date Finished, Sept. 26
Acid Treatment of Well 77
Summary:

Materials pumped down well.

Water—before any acid was added to the well .....6680 gallons

Water—pumped down outside the acid hose 3050 gallons

The water pumped with the acid by the acid pump could not be measured.

Total.....9730 gallons

Acid.

1320 gallons or 13,000 pounds of 30% acid or 3,900 pounds of 100% HCl.

Water pressure on well. 12 pounds per square inch, maintained at the constant value by an overflow 25 feet above the well.

Rate of water into the well at the start of the experiment. Gallons per hour.....25

Rate of water into the well at the end of the experiment, with the acid pump also pumping more water.15

Rate of water into the well at the end of the experiment, after the acid had been shut off for 24 hours..15

Depth of well at the start of the experiment.....1505 ft.

Depth of well Sept. 26, at the end of the experiment .....1490 ft.

Physical Laboratory

THE DOW CHEMICAL COMPANY

File No. 0109

Subject Increasing brine flow from Well 77

By Thompson

Acid Treatment of Well 77 to increase its productivity.

Previous Treatment:

Water — 9730

No. 30% acid — 13,000 lbs.

Wash after acid 2837 gallons

Tank at Well 59" Dia.

Date	Time	Total Time Hours	Hours Off	Meter	Gals. H_2O per H.	Total Gals.	Acid	Amount Add	Total	Lbs. Acid	Press. on Well
							33"				42
9-30	4:00	0		3815			27"	72	72		21
10-1	9:30	17.5		3970	8.9	155	26.5	6	78		38
10-1	10:30	1.0					41.5				38
10-1	10:30						40	18	96		40
10-1	4:00	5.5		4235	48.1	420	35	60	156		40
10-2	11:00	19.0		4728	26.0	913	34.5	6	162		40
10-2	12:30	1.5					50				
	12:30						48.5	18	180	14,800	40
10-2	4:00	3.5		4850	35	1035	43.5	60	240		40 lbs.
10-3	10:00	18.0		5274	23.6	1459	42.	18	258		40
10-3	4:00	6		5394	20	1579	38	48	306		40
10-4	9:30	17.5		5762	21	1947	37.5	6	312		40
10-4	10:30		½ hr.				52.5				40
10-4	11:00	1.5		5800	21	1985					40
10-4	1:00	2		5860	30	2015					40
10-6	11:00	46		6780	20.4	2945	39	162	474		40
10-6	12:00	1		6840	20	2965	44		474		40

Plaintiff's Exhibit 362

1820

Plaintiff's Exhibit 362

Date	Time	Total Time Hours	Hours Off	Meter	Gals. H_2O/Hr.	Total Gallons	Acid	Amount Added	Total	Press.
10-6	4:30	4.5		6992	18.5	3043	43	12	486	40
10-7	9:30	17		7210	13	3261	39.5	54	540	40
10-7	3:30	6		7324	19	3375	37.5	24	564	40
10-8	7:30	16		7627	18	3678	32.5	60	624	40
10-8	12:00	4.5					31	18	642	40
10-8	"						36			40
10-8	5:00	5		7813	37	3864	33.5	30	672	40
10-9	10:30	17.5		8127	17	4178	28	66	738	40
10-9	12:00	1.5					27.5	6	744	40
10-9	"						40			40
10-9	3:00	3		8213	28	4264	38	24	768	40
10-10	10:00	19		8568	19.6	4619	31.5	78	846	40
10-10	"						47			40
"	2:00	4		8650	20.5	4701	45	24	870	40
10-11	11:30	20.5		9015	18.4	5066	40	60	930	40
10-13	9:00	47.5		9838	17.8	5889	28.5	138	1068	40
10-13	5:00	8		9988	18.7	6039	26	30	1098	40
10-14	10:00	17		10305	18.4	6356	22	48	1146	40
10-14	5:00	7		10305	?		20.5	30	1176	40

Electricity was off three times during P.M. and meter run backwards. Current was still off at 5 P.M.

10-15	9:30	17.5	½	10725	25	6781	17	42	1218	40
10-15	3:30	6		10840	19.1	6896	15	24	1242	40
10-16	9:00	17.5		11160	18.1	7216	11.5	42	1284	40

Date	Specific Gravity	Ph.	Acid
10–22	1.062	1.3	1.8
23	1.113	2.4	0.15
24	1.192	3.5	0.12
27	1.211	4.95	0
28	1.213	4.9	
29	1.219	4.9	
30	1.221	4.9	
31	1.225	5.1	

11– 3—Quinlan to quit bringing in sample.

DESCRIPTION OF THE EXPERIMENT

Work was started at Well 77 on August 18, 1930, when we started installing an acid tank, the hose in the well and the acid pump. It took some time to get an adequate water supply for the experiment. Two points were pounded into the sand at the well, but would not give enough water to keep the pump primed. A nearby discarded flowing well was pumped for 24 hours but the water obtained was too dirty to put down the brine well. Finally a half mile pipe line was run to Well 77 where the drillers had left two good well points in the ground. A special low capacity, high head centrifugal pump was installed there on September 5, and has been entirely satisfactory.

Before adding acid to the well, it was flushed out with 6700 gallons of water. However, about 150 gallons were required to fill up the casing. The average rate at which the water ran into the well under 12 pounds pressure was about 25 gallons per hour. On September 6 we started pumping acid down the well and continued it until Sept. 24, except for two periods of 17 hours when the acid pump went bad, and one period of 24 hours to take out the hose and inspect it. The only trouble encountered was the water meter occasionally sticking to the low rates.

The experiment was stopped on September 24 because the acid and water from the acid pump seemed to back up the water, which normally went down around the outside of the hose, and made the meter connected to it to run backwards. We were afraid the acidified water might reach the casing and attack it if we continued. The hose was pulled from the well, and from its appearance and that of the supporting cable, it was evident that the acid had backed up to about 1300 feet, which is several hundred feet below the bottom of the casing, (1138 feet). The bottom of the well measured with the standard well chain is at 1490 feet, about 15 feet higher than it was originally.

We have pumped 13,000 pounds of 30% acid into the well, approximately 9,000 pounds less than into Well 80 before we attempted to pump it. Our present plan is to continue to pump in water until Sept. 29, then put back the hose and pump in about 15,000 pounds more of acid, then wash it with water. It will then be ready to have its flow tested.

PLAINTIFF'S EXHIBIT 363

Physical Laboratory
THE DOW CHEMICAL COMPANY

File No. 0075
By N.P.

To Acid treatment at Well 80—
Subject: To increase porosity of sand.
Charge No. 223
Date Finished, 8-18-30
Results:

Acid and water or brine was pumped down the well to attack any limestone formation that might be present. Experiment was carried on from July 7 to Aug. 15. In the time 22,000 pounds of 30% HCl solution was pumped down the well.

At the start of the experiment the brine level in well was 108′ from the top. At the end of the time it was 20′, the difference being due to the difference of the densities of brine and water.

Water was pumped down well for one week during the time the rate fell from 0.4 gal. per minute to 0.1 gal. per minute.

The rest of the time brine was used to keep the acid going down the well. The well took brine at a rate of 0.5 to 0.3 gal. per min.

Description of Work:

The brine level in well was measured by conductivity cell on end of wire and was 108′ from top of well. This made a head of only $108 \times \frac{1}{2.3 \times 1.25} = 38\#$ pressure for putting down brine or 30# for putting down water. On August 16 when the work was stopped the level was 20′ from the top, and on Aug. 15 it was 26′ from the top.

PLAINTIFF'S EXHIBIT 364

Physical Laboratory
THE DOW CHEMICAL COMPANY

To J. J. Grebe By N. Poffenberger File No. 9221
Subject: Dissolving Scale in Tubes with Acid using some Arsenic Compounds to Prevent Corrosion of the Iron Tubes.
Charge No. 1802
Date Rec'd, 10-31-29
Date Finished, 7-21-30

Samples of silicate scale were obtained from Nelson Griswold at the Power Plant. He claimed they were not affected by concentrated HCl and concentrated HNO_3, so no work was done on the scale.

The use of arsenic compounds to inhibit hydrochloric acid corrosion was checked by laboratory corrosion tests, using acid up to 6 N. (20% HCl).

Strips of sheet iron, about 6" long and ¾" wide, weighing about 10 grams were used in the work. They were placed in 500 c.c. of acid and allowed to stand 24 hours before they were removed, brushed and weighed.

Sodium arsenate and sodium arsenite are both effective in retarding corrosive action of HCl at room temperatures. In general the arsenate is the more effective except at the highest concentration used—10 grams per 500 cc. However they do not prevent corrosion.

The table given below shows the effect of both change of acidity and changes in the amount of arsenic compound.

Loss in Weight in 24 Hours Expressed as Percentages

500 cc. acid — 2 grams of arsenic salt

Normality	Percent Loss wt. of iron— no arsenic	Per-cent with Sodium Arsenate	Per-cent with Sodium Arsenite
1	6.7	0.3	0.2
4	28.8	0.3	1.2
6	100.0	1.7	5.5

Loss in Weight in 24 Hours Expressed as Percentages

500 cc. = 6 N. HCl — amount of salt varied

Grams salt per 500 cc.	Percent Loss weight No arsenic	Percent with Sod. Arsenate	Percent with Sod. Arsenite
0	100		
2		1.7	5.5
4		1.4	2.2
6		1.3	1.7
8		1.1	1.2
10		1.4	.7

PLAINTIFF'S EXHIBIT 366

Case 172

Richard H. Carr and Howard C. Humphrey

Method for Increasing Fluid Production from Oil Wells.

This invention relates to an improved method for facilitating and increasing the flow of oil or gas wells, especially wells producing from sand formations, and it is an object of the invention to treat such producing sand formations with suitable chemical reagents possessing the ability to react with such formations to partially discharge or disintegrate the same or increase the porosity thereof in order to render the sand formation around the well bore permeable to the flow of the desired fluid into such a bore. It often occurs that the fluid producing area of a well is disposed in what is referred to as "hard" sand which restricts the passage of the desired fluid (oil or gas) into the well bore and the present invention provides for the chemical treatment of such sand, and also other sand formations to render the same more permeable to the passage of fluid and the consequent delivery of such fluid to a well bore.

In certain sand formations of producing wells, the sand particles are united by a cementitious binder which closely unites the sand grains or particles and decreases the porosity of the formation to the end of greatly restricting the desired inflow of fluid into the well bore, and it is another object of the present invention to provide selected chemical reagents which possess the ability to attack and dissolve the cementitious binder uniting the sand particles, whereby to disintegrate or dissolve the binder, thereby increasing the porosity of the sand formation and providing for increased fluid flow.

It is another object of the invention to introduce an acid reagent into the oil or gas producing formation serving a well under pressure so that the pore space of the sand in the area penetrated by the reagent will be enlarged or increased to reduce the restriction to flow of the desired fluid into said well. It has been proposed heretofore to in-

crease oil well production by applying hydrochloric or muriatic acid to the producing formation of a well disposed in limestone, whereby to permit such an acid to attack the lime rock to increase its porosity. The present invention, however, deals with the problem of securing increased porosity and fluid flow in wells producing from sand formations which provide greater difficulties than exist in the treatment of limestone. Such sand formations comprise dense compact grains often united by a more or less cementitious binder composed of a mixture of materials consisting usually of clays, calcium, metallic oxides and other substances. The restricted pore spaces of these materials are often such as to greatly hamper or limit the passage of oil or gas into the well bore, and to enlarge such pore spaces to admit of freer fluid passage therethrough has been a long standing problem on the part of oil well operators. Explosives have been used in such capacities with but a small degree of success, owing to their limited range of influence in the formation. Explosives also involve expensive cleaning and the possibility of loss of production as well as other objectionable features. Since lime does not predominate in sand formations, the use of hydrochloric acid alone is not effectual or sufficient in most sands for the purpose of increasing such porosity, and while the use of the chemical disintegration method would be preferable over explosives by reason of its safety, assurance and economy, yet the industry has and is at present using explosives in efforts to attain increased production from sand producing regions.

We have discovered that the cementing materials restricting the flow of fluids in producing sands of a well can be successfully disintegrated to cause augmented oil or gas flow into the well, this being attained by the use and manner of application of certain selected chemical reagents as hereinafter more fully described.

In carrying out our process, a mixture of hydrochloric and nitric acids is introduced into the well bore and the producing sands through the usual tubing. By advancing

these acid reagents through the producing sands under pressure, the pore space of the area treated thereby around the well bore will be enlarged and the benefits of the process obtained by rendering the sand more permeable to the passage of the desired fluids. We have, also, found it necessary to use hydrofluoric acid in the treatment of certain sands when hydrochloric and nitric acids are relatively ineffectual.

Additional features of our process involve: the preliminary treatment of the producing sands, prior to the addition of the acid reagents, with carbon tetrachloride or other solvent, whereby to dissolve paraffinic, asphaltic or other coatings from the sands adjacent to the cavity, thus rendering the same suitable for immediate reaction with the acid reagents; again, we treat the surfaces of the tubing or other metallic parts of the well bore equipment with a coating to prevent the acid reagents from appreciably attacking and injuring such metal parts with which the agents come into contact; for instance, the interior of the tubing may be coated with cellulose, nitrate or other acid resisting varnish when hydrochloric or nitric acids are used, or in the case of the use of hydrofluoric acid we preferably line the tubing with a coating of solidified paraffin wax to render it resistant to acid attack.

For a further understanding of the invention, reference is to be had to the following description and the accompanying drawing, in which one embodiment of our invention has been set forth. In said drawing: Figure 1 is a diagrammatic view in vertical section of an oil well disclosing an arrangement admitting of the use of our process thereon; Figures 2 and 3 are detailed microscopic views disclosing the appearance of the producing sand when magnified before and after treatment thereof in accordance with the invention.

Referring more particularly to the drawing, the numeral 1 designates the casing of an oil well. The casing-head is indicated at 2, 3 is a control valve therefor, 4 indicates the tubing extending downward through the casing

and space therefrom to produce an annular chamber 5 between the adjacent walls of the tubing and the casing. The bottom of the casing is provided with the usual strainer 6 which is disposed in the liquid producing sand 7 in the bottom of the well bore.

In order to attack these sands to increase porosity and permeability and reduce fluid flow restricting substances, the well is first filled with a liquid possessing a lower specific gravity than the acid reagents, oil being particularly suitable and economical for this purpose. In the filling of the well, the oil may be introduced either through the casing or the tubing. In either of them both the casing and the tubing are first filled with liquid in such a manner as to eliminate free gas in the well bore and render it hydrostatically controllable.

Following this operation a desired amount of the acid reagent is introduced into the tubing. If a mixture of hydrochloric and nitric acids is used, the said acids may be retained in a container 8 which is provided with valved outlet line 10 leading to the inlet side of a pump 11. The outlet side of said pump is connected by means of a line 12 provided with a control valve 13 with the upper end of the tubing 4. As soon as a desired amount of the acids has been so introduced into the tubing, the outlet valve 3 of the casinghead is closed, and since the well is full of oil, the acids, being heavier than the oil, settle to the bottom of the well with the oil above the same, the escape of the oil through the space 5 being prevented by the closing of the casinghead outlet. The acid is then displaced from the tubing by pumping an additional quantity of oil into the tubing. This oil may be obtained from any suitable source 9 and is preferably advanced by the pump 11 to place the desired pressures on the acid reagents, forcing the latter into the producing sands of the well bore and insuring complete displacement of said reagents from the tubing into the producing formation. As soon as the reagents have been forced into the producing sands, the control valve at the top of the tubing may be closed and the well left stand-

ing for a sufficient period of time to permit complete reaction of the reagents with the producing sands.

As previously stated, it may be preferable before introducing the acids into the sands to treat the latter and the lower part of the well bore with a solvent, such as carbon tetrachloride. This solvent dissolves paraffinic and asphaltic coatings of a hardened or solidified nature so that the acid will be able to reach directly the materials to be dissolved. Also, the tubing, casing, or other metallic parts which come into contact with the acid reagents may be treated with acid resisting coatings. In this connection the said parts may be covered with an acid resisting varnish, such as cellulose nitrate, or may be covered with paraffin. In this manner the use of the acid is rendered practicable and will not injure the more costly metallic equipment.

We do not limit ourselves to the specific reagents above set forth nor to any particular quantity or percentage thereof. The acid reagents recited are of ordinary commercial strength and their quantity will vary with the character of the producing formation. In certain wells which we have treated in accordance with our process, we have substantially filled the tubing with the acid reagent before pumping in added oil to displace the reagent from the tubing into the producing formation. Obviously, however, this amount may be varied by increasing or decreasing the same as circumstances may require. After the reagent has been allowed to react with the producing formation for the desired period of time, the well may be swabbed or pumped to remove the fluids or solids suspended therein and the operation of the well resumed.

The condition of some depleted oil or gas producing areas is such that the rock pressures have been reduced by withdrawals of oil and gas to such an extent that undesirable quantities of oil would penetrate and pass into the producing formation before it would be possible to establish a column of fluid to the top of the bore hole. In such cases, to admit of the use of the acid reagents previously described under such conditions, the said acid reagents

would be introduced into the producing formation by delivering it without the loading of a column of oil, or under a height of oil fluid in the bore hole which would be commensurate with the rock pressure of the area and suitable to conditions.

What is claimed is:

1. The method of increasing the flow of wells producing a desired fluid from sand formations, which consists in introducing into the well a chemical reagent possessing the ability to react with the producing formation to increase the pore space therein in communication with a well bore, whereby to reduce the restriction originally offered by the formation to the inflow of the desired fluid into the well bore.

2. The method of increasing the flow of wells producing a desired fluid from sand formations, which consists in introducing into the well an acid reagent possessing the ability to react with the producing formation to increase the pore space therein in communication with a well bore, whereby to reduce the restriction originally offered by the formation to the inflow of the desired fluid into the well bore.

3. The method of increasing the flow of wells producing a desired fluid from sand formations, which consists in introducing into the well under pressure a chemical reagent possessing the ability to react with the producing formation to increase the pore space therein in communication with a well bore, whereby to reduce the restriction originally offered by the formation to the inflow of the desired fluid into the well bore.

4. The method of increasing the flow of wells producing a desired fluid from sand formations, which consists in introducing into the well under pressue an acid reagent possessing the ability to react with the producing formation to increase the pore space therein in communication with a well bore, whereby to reduce the restriction originally offered by the formation to the inflow of the desired fluid into the well bore.

5. The method of increasing the flow of wells producing from sand formations, which consists in introducing into the well a chemical reagent which attacks the binding materials formed between the sand particles, whereby to effect the dissolution of such binding materials, and in subsequently removing the dissolved binding materials from the well.

6. The method of increasing the flow of wells producing from sand formations, which consists in introducing a mixture of hydrochloric and nitric acid into such producing sands to effect the dissolution of the binding materials uniting the sand grains, whereby to leave the sand formation adjacent to the producing region of the well bore in a state admitting of the free passage of the desired fluid therethrough.

7. The method of increasing the flow of wells producing from sand formations, which comprises introducing into such sand formations through the tubing of the well a chemical reagent in the form of a mixture of hydrochloric and nitric acid, and applying pressure to said reagent to distribute the latter through a comparatively wide region contiguous the well bore in such producing sands.

8. The method of increasing the flow of wells, which consists in introducing into the producing sands of such a well a chemical reagent comprising a mixture of hydrochloric and nitric acids, and applying pressure to said reagent to distribute the latter through the producing sands of the well supplying fluid to the well.

9. The method for increasing the flow of oil wells producing from sand formations which consists in dissolving the binding materials formed between sand grains by applying a dissolving agent thereto, and removing such materials following their dissolution from the well, whereby to provide interstitial spaces between the sand grains admitting of the relatively free passage of oil.

10. The method of increasing the flow of oil wells producing from sand formations which consists in introducing through the bore of such a well and into contact with the

sand formation thereof a solvent capable of dissolving paraffinic and asphaltic coatings, then introducing into contact with the cleaned sands an acid reagent capable of disintegrating such sand formations sufficiently to admit of relatively free flow of oil therethrough.

11. The method for facilitating the flow of oil into the producing region of a well bore, which consists in providing such a well with the usual casing and tubing, introducing into the well a body of oil by way of the tubing to fill the tubing and the annular space formed between the tubing and the casing with said oil in such manner as to substantially eliminate free gas, introducing into the tubing an acid reagent consisting of a mixture of hydrochloric and nitric acids, and applying pressure to the reagent in said tubing to displace the latter and force the same into contact with the sand formation.

PLAINTIFF'S EXHIBIT 367

Richard H. Carr and Howard C. Humphrey
"Chemical Reagent for Use in Oil Wells"—Case 174.
Filed Oct. 10, 1932—Serial No. 637,099.
Assigned to The Pure Oil Company.

This invention relates to an improved compound or chemical reagent for treating the producing formations of oil or gas wells to facilitate the flow of a desired fluid into the bore of such a well, and it is an outstanding object of the invention to provide an improved reagent which possesses the capability of reacting with such producing for-

mations to partially dissolve or disintegrate the same, or increase the porosity thereof, in order to render such formations around the well bore more permeable to the flow of the desired fluid into the bore and thereby increase the fluid output of a well so treated.

In our prior copending application, Serial No. 620,180, filed June 30, 1932, we have set forth a process for accomplishing the above by the use of a reagent in the form of hydrofluoric and other equivalent acid, which is introduced into the well bore through the customary tubing or casing and advanced, preferably under pressure, into the producing formation of the well, in order that the acid reagent will attack the formation to afford the desired increased flow of fluid over that normally afforded by the formation. We have found in the operation of our process that such an acid reagent, while highly effective in increasing the porosity and fluid output of the producing formation, possesses the disadvantage of attacking the metallic members of an operating well, such as the ordinary tubing and casing, into which the reagent comes into contact, causing their premature impairment together with high replacement costs. To overcome the damaging effects caused by corrosion and of a detrimental character to the tubing and casing, we heretofore coated such metallic parts with a coating of various substances, such as acid resisting varnish, solidified paraffin wax and the like, to such an extent as to resist acid attack. The coating of the metal parts however, adds considerably to the expense of using the process and is not altogether satisfactory in affording complete protection of the metal from acid attack.

We have discovered that improved resistance of the metal in the well bore to the corrosive effects of such reagents may be obtained through the use of a reagent modified in its action by the addition thereto of relatively small quantities of compounds belonging to the nitrogen group, whereby the reagent may be passed harmlessly through metallic members or over metallic surfaces without exerting any material detrimental action thereon. In our afore-

said prior application, we have disclosed the use of an acid reagent consisting of hydrofluoric or hydrochloric acids, or a mixture of hydrochloric and nitric acids. These halogen-containing acids, especially hydrofluoric and hydrochloric acids are quite active in their attack upon sand and limestone producing formations from which hydrocarbon oils and gases emanate, but as is well known, such acids readily combine with certain metals, such as iron, causing the undesired corrosive effects in the metallic members of the well bore, as above described. However, by the addition to such acids of a modifying or inhibiting compound, selected from compounds belonging to the nitrogen group, as hereinafter specified, a neutralizing effect is obtained preventing the acids from detrimentally attacking metallic surfaces but without any substantial impairment of their ability to dissolve or disintegrate and vigorously attack the minerals found in the producing formations. Thus in producing our improved reagent for use in the capacity set forth, we may provide a mixture composed of hydrofluoric, hydrochloric or hydrochloric and nitric acids to which we add a small per cent, varying from approximately .2% to 3.00% of a compound belonging to the nitrogen group including arsenic, antimony or bismuth. Among these compounds, we have found that by adding to the acid approximately ½ of 1 per cent by weight of arsenic acid or arsenious oxide, very practicable results can be obtained. A specific example of our improved treating agent may consist of 99.5% of hydrofluoric acid combined with .5% of arsenic acid or arsenious oxide. The treating agent thus formed may be pumped through pipes, casings, tubes or the like and maintained therein for appropriate periods of time necessary in permitting the reagent to react on the producing formations and yet there will be no appreciable deleterious action on the metals composing such pipe members. Moreover, it is usually unnecessary, as heretofore, to coat the metal members with protective coatings such as paraffin or the like, although such coatings may be used if desired. The methods for using the reagent in treating producing for-

mations constitutes the subject matter of our aforesaid co-pending application and therefore detailed explanation thereof is considered unnecessary herein, inasmuch as the present invention has to do with the compounding of such a reagent suitable for the purposes specified. The amount of the modifying or inhibiting agent used depends upon the depth of the well bore or the length of the metallic members disposed in such a bore and the surface area of the metal to be protected, the inhibitor serving to produce a protective coating or deposit on the surfaces of the metal with which the reagent comes into contact to minimize its corrosive action.

What is claimed is:

1. An acid reagent for treating the producing formations of oil wells to increase fluid production composed of a mixture consisting principally of hydrofluoric acid and a relatively small quantity of an arsenic compound.

2. An acid reagent for treating the producing formations of oil wells to increase fluid production composed of a mixture consisting principally of hydrofluoric acid and approximately one-half per cent by weight of an arsenic compound.

3. An acid reagent for treating the producing formations of oil wells to increase fluid production composed of a mixture consisting principally of hydrofluoric acid and a relatively small quantity of an arsenic compound selected from a group consisting of arsenic acid and arsenious oxide.

4. A non-corrosive acid reagent for treating the producing formations of oil wells composed principally of hydrofluoric acid and a small quantity of a modifying agent in simple admixture with the hydrofluoric acid to neutralize its normal corrosive action on metallic members.

5. A chemical compound for use in increasing the flow of fluid from the producing regions of oil or gas wells, comprising an acid reagent possessing the ability to react with the producing formation of such a well to increase the pore space therein in communication with a well bore, and a modifying agent in simple admixture with said acid re-

agent, the proportions of said modifying agent being such with respect to the acid reagent as to prevent the latter from deleteriously effecting metallic surfaces with which it comes in contact but without substantially impairing the capabilities of the reagent to react with the fluid-producing formation of an oil or gas well.

6. An acid reagent for treating the producing formations of oil or gas wells to increase fluid production therefrom, comprising a mixture consisting principally of a halogen-containing acid and a relatively small quantity of a compound belonging to the nitrogen group.

7. An acid reagent for treating the producing formations of oil or gas wells composed principally of an acid selected from a group comprising hydrofluoric, hydrochloric and/or nitric acids, and a small quantity of a modifying agent in simple admixture with such an acid to neutralize its normal corrosive action on ferrous metals, said modifying agent being selected from the more metallic-like members of the nitrogen group.

PLAINTIFF'S EXHIBIT 368

Richard H. Carr and Howard C. Humphrey

Method for Introducing Acid Reagents into Oil Wells by Gas Pressures.

Filed Oct. 21, 1932—Serial No. 638,950—Case 177.

This invention relates to an improved process for introducing acid reagents into deep wells, such as those encountered in the oil and gas fields, wherein the reagents

serve to attack the fluid-producing formations of such wells for the purpose of augmenting fluid production therefrom.

It is an outstanding object of the present invention to provide an improved method whereby the delivery of the acid reagent to the producing formation is rendered more positive and certain and effected in a readily controlled manner.

In accordance with the present invention, a selected acid reagent is introduced into the well bore through the customary tubing or casing and permitted to settle to the bottom of the well contiguous to the fluid-producing sands, lime rock or other producing stratum, and wherein the desired penetration of the reagent into the producing stratum is obtained through the employment of gas under pressure, which is so applied to the reagent as to positively force the latter into the pores or interstitial spaces of the producing stratum to attack, disintegrate or partially dissolve matter which tends to obstruct and interfere with the desired flow of fluid into the well bore.

In the accompanying drawing, there is disclosed a diagrammatic figure, partly in vertical section, of a deep well provided with means for carrying out the present invention.

Referring more particularly to the drawing, the numeral 1 designates the well bore, the numeral 2 the string of casing positioned in the bore and opened at its lower end to the producing stratum 3 in contact with the bottom of the well bore 1. Within the casing 2, there is arranged the usual tubing 4 which extends from the producing stratum through the casing head 5 provided at the top of the casing 2 above the ground surface 6. The casing head is provided with the customary valved outlet 7, and the tubing, above the casing head, is provided with a control valve 8.

In practice an acid reagent, which may consist of hydrochloric, muriatic or sulphuric acid or, in certain instances, hydrofluoric or nitric acid, or combinations of these acids, is introduced through the tubing or casing. After a

desired amount of the acid has been so introduced, the outlet 7 is closed as well as the tubing valve 8. Gas is then delivered to the tubing through the pipe line 9 by way of a pump or compressor 10, or from any other suitable source, so that a gas pressure is developed in the tube which forces the acid reagent into the producing stratum, indicated at 3. If desired, a packer 11 may be arranged in the annular space between the lower portion of the tube and the casing 2 so that the reagent will be positively advanced to the producing formation under the gas pressures applied thereto and not forced upwardly of the casing. If the packer is not employed, the annular space between the tubing and casing may be filled with a fluid, such as oil and which possesses a lower specific gravity than the acid reagent in order to assure the delivery of the full quantity of such reagent throughout the fluid-producing area of the well. Again, said annular space may contain a gas under sufficient pressure to prevent the rising of the acid. Also, it is within the range of the invention to introduce the acid reagent through the casing, if desired, rather than the tubing, although as a matter of practice, it is preferred to employ the tubing in this connection.

The reagent so introduced reacts with the producing formation dissolving obstructing matter, enlarging both cavity and pore area and removing obstructive substances which tend to restrict the flow of the desired fluid into the bottom of the well bore. The process thus provides for revivifying wells whose production rate has receded from normal levels and in many instances, the process provides for a much greater output of fluid than that which the well originally produced when first drilled. The process may be applied to newly drilled wells as well as restoring the production rate of old wells. If desired, the treating reagent may contain a small percentage of an arsenic or any other suitable inhibitor to prevent the acid from detrimentally affecting the metallic members in the well bore.

The acid reagent may be introduced directly into the well bore with the ordinary tubing removed, either by being

poured into the bore or by being lowered into the bottom of the well bore in a receptable known as a dump bailer, the upper end of the well bore being closed and gas under pressure, obtained from any suitable source, delivered to the well bore to cause penetration of the reagent into the producing formation.

What is claimed is:

1. The method of introducing acid reagents into the producing stratum of a deep well, which consists in passing such a reagent through the tubing of a well into the vicinity of the producing formation, obstructing the well bore to retain the acid in the vicinity of the producing formation and to overcome any tendency thereof to rise in the well bore, and applying gas pressure to the acid reagent to positively advance the latter through desired areas of the producing formation.

2. The herein described method for introducing acid reagents into the producing formations of oil wells and the like, which consists in delivering the acid reagent to the bottom of the well bore in the immediate vicinity of the fluid producing formation of such a bore, retaining the reagent in the bottom of said bore against movement in an upward direction through said bore, and applying gas pressures to the acid reagent to positively advance the latter through the pores and interstitial spaces of the producing formation contacting the well bore.

3. The herein described method for introducing an acid treating reagent into the producing formation of a well bore, which consists in delivering the reagent to the bottom of said bore in the immediate vicinity of the producing formation, sealing the bore against the rise of the reagent therein, and then applying gas pressures to the reagent to force the latter through the pores and interstitial spaces of the producing formation.

4. The herein described method for introducing an acid treating reagent into the producing formation of a well bore, which consists in passing the acid reagent through the customary tubing of a well bore and delivering

the same to the bottom of the bore in contact with the fluid-producing region of said bore, sealing the customary casing of the well bore to prevent the rise of the reagent in said casing and around the tubing and forcing a gaseous fluid under pressure into said tubing and in contact with the acid reagent to positively advance said reagent through the pores and interstitial spaces of the producing formation.

5. The herein described method for introducing an acid treating reagent into the producing formation of a deep well, which consists in suitably depositing the reagent in the bottom of the well bore contiguous to the producing formation, and causing penetration of the reagent into the producing formation by the application to the reagent of a gas under pressure.

6. The herein described method for introducing an acid reagent into the producing formation of a deep well, which consists in passing such a reagent through the tubing of a well into the vicinity of the producing formation, sealing the annular space formed between the tubing and the customary surrounding casing with a fluid, and forcing gas under pressure through the tubing to cause the acid reagent to penetrate the producing formation.

7. The herein described method of introducing acid reagents into the producing stratum of a deep well containing the customary casing and tubing, which consists in passing an acid reagent through the tubing and delivering the same to the bottom of the well bore contiguous to the producing stratum, introducing a gas under pressure through the tubing and into contact with the acid reagent to positively advance the latter into the producing stratum, and maintaining a body of gas under pressure in the annular space formed between the tubing and casing to prevent the rise of the reagent into said space while gas pressures are being applied to the reagent to cause penetration thereof into the producing stratum.

PLAINTIFF'S EXHIBIT 369

This Agreement, made and entered into this 31st day of January, 1933, by and between The Dow Chemical Company, a corporation organized under the laws of Michigan, with its principal office at Midland, Michigan, hereinafter referred to as Dow, party of the first part, and The Pure Oil Company, a corporation organized under the laws of Ohio, with its principal office at 35 East Wacker Drive, Chicago, Illinois, hereinafter referred to as Pure, party of the second part, Witnesseth:

Whereas, Dow has developed a solvent which, when applied to a producing oil well, is intended to cause greater porosity of the oil bearing strata and thereby increase production; and, for its protection in the manufacture, use and sale of said product, has obtained United States Letters Patent 1,877,504 entitled "Treatment of Deep Wells"; and

Whereas, Dow has continued its research and developed other products and materials for the treatment of deep wells which may be used in connection with said solvent or separately on which United States Letters Patent have been applied for; and

Whereas, Dow is equipped to manufacture and transport such products and to supervise the treatment therewith of oil producing wells and provide facilities for such purposes; and

Whereas, Pure is a large producer of oil and other petroleum products and operates many producing wells in Michigan and various other states and has also been actively engaged in research work on the treatment of oil wells to increase production therefrom and has devised a new and novel process for the introduction of acid into wells and, for its protection in reference thereto, has obtained United States Letters Patent 1,891,667 entitled "Method of Facilitating the Flow of Wells"; and Pure has continued its research upon the treatment of oil wells and has made further discoveries and inventions and, for the

issuance of patents thereon, applications are now pending; and

Whereas, in the treatment of its oil and gas wells Pure uses an inhibited acid known as Dowell-X and it is mutually desired that Dow shall continue as Pure's source of supply for its Dowell-X and other inhibited acids;

Now therefore, in consideration of the mutual covenants herein contained, the parties hereto agree as follows:

I.

Dow shall grant unto Pure without royalty charge a non-exclusive license under Patent 1,877,504 and under any other patents which Dow may acquire, own or control relating to acid treatment of oil or gas wells.

II.

Pure shall grant unto Dow and its subsidiaries a non-exclusive license under Patent 1,891,667 and under any other patents which Pure may acquire, own or control relating to acid treatment of oil or gas wells. Dow shall pay Pure in manner hereinafter specified a royalty of $5.00 for each and every well which shall be treated by Dow, its subsidiaries, agents or representatives after the execution of this contract, until the royalties so paid shall amount to $15,000 whereupon said obligation to pay royalty shall terminate. Pure agrees to accept capital stock in Dowell Incorporated in lieu of cash for royalty that may accrue, with the understanding that when accrued royalty shall amount to $5000 Dowell Incorporated shall issue unto Pure a certificate for fifty shares of its $100 par value capital stock. At each time thereafter when accrued royalty shall amount to $5000 a certificate to Pure for fifty additional shares shall likewise be issued until Pure's holding of capital stock in Dowell Incorporated shall have reached $15,000.

III.

Pure hereby acknowledges the validity of Dow's Patent 1,877,504, and Dow likewise acknowledges the validity of Pure's Patent 1,891,667. The parties mutually agree to cooperate with each other for the protection of the licensed patents with the understanding, however, that neither of the parties shall be obligated to the other beyond furnishing, without charge, services of attorneys and other technical employees under general salary or retainer.

IV.

Pure agrees wherever practicable in the major producing fields in the East and Southwest to permit Dow to utilize Pure's facilities for the handling of acid treatment of wells upon condition, however, that Dow shall pay a reasonable rental or service charge for use of such facilities.

V.

Dow hereby agrees to sell to Pure and Pure agrees to purchase and accept from Dow the merchandise herein described for a period of ten years from the date hereof (subject to certain limitations hereinafter recited) according to terms and conditions named below:

Article—Dowell-X, or other inhibited acids.

Quality—Same as now currently supplied by Dow to Pure, namely, 15% Acid Inhibited and/or 20% Acid inhibited, as required by Pure.

Quantity—Pure's requirements for its own use only and not for resale, not exceeding 50,000 gallons per month. It is understood that this clause in no way limits Pure in the quantity of acid it may buy and use in the treatment of its oil and gas wells but is intended only to limit the quantity of acid which Dow may be required to deliver to Pure. In event Pure's requirements exceed 50,000 gallons

per month, Dow shall be given the opportunity of supplying same at competitive prices and, in event of Dow's declining to so supply, Pure may purchase such excess requirements in the open market.

Package—Tank cars or containers furnished by Pure.

Price—(A) For such acid as Pure desires to take from Dow's plant at Midland, Michigan, the price shall be $50.00 per thousand gallons for the 15% acid inhibited and $68.35 per thousand gallons for the 20% acid inhibited, all prices f.o.b. plant, Midland, Michigan.

(B) For Pure's use at points distant from the Midland field where Dow has a supply of acid through arrangements with local producers of acid at such remote points, Dow will make it possible for Pure to secure such acid at the cost of the raw acid to Dow, plus a reasonable price for the inhibitor used, if supplied by Dow, and plus a reasonable charge for compounding or diluting where Dow is equipped to and does so dilute or compound said acids.

Terms—One per cent ten days, thirty days net; payable in gold or its equivalent in United States currency.

Deliveries—Pure shall give Dow reasonable notice covering shipments and shall take deliveries in approximately equal monthly quantities.

It is agreed that upon Pure's written request other acid compounds may be substituted for Dowell-X, providing that such compounds are to be used in the treatment of oil and gas wells, and in such event suitable adjustments will be made and the price determined by the relative acid content in such other compounds as compared with Dowell-X, and shall be further corrected for greater or lesser cost involved in the manufacture.

It is mutually agreed that either of the parties hereto may terminate this agreement on the 31st day of December, 1937, or on the 31st day of December in any succeeding year, by giving written notice to the other at least sixty days prior to the date of cancellation.

Neither party shall be held responsible for any default occasioned by war, fire, strike, accident, civil or military authority, or other contingencies beyond its control.

In Witness Whereof the parties hereto have caused these presents to be executed by their officers duly authorized on the day and year aforesaid, and have hereunto caused their respective corporate seals to be affixed.

The Dow Chemical Company
By Willard H. Dow, President.

Attest: Earl W. Dimmitt,
Assistant Secretary.

The Pure Oil Company,
By R. Wm. Ilvane, Vice-President.

Attest: H. Guy Chase,
Asst. Secretary.

PLAINTIFF'S EXHIBIT 370

This Agreement, made and entered into this 30th day of June, 1934, by and between The Dow Chemical Company, a corporation organized under the laws of Michigan, with its principal office at Midland, Michigan, hereinafter referred to as Dow, party of the first part, and The Pure Oil Company, a corporation organized under the laws of Ohio, with its principal office at 35 East Wacker Drive, Chicago, Illinois, hereinafter referred to as Pure, party of the second part, Witnesseth:

Whereas, Dow has developed a solvent which, when applied to a producing oil well, is intended to cause greater porosity of the oil bearing strata and thereby increase production; and, for its protection in the manufacture, use

and sale of said product, has obtained United States Letters Patent 1,877,504 entitled "Treatment of Deep Wells"; and

Whereas, Dow has continued its research and developed other products and materials for the treatment of deep wells which may be used in connection with said solvent or separately on which United States Letters Patent have been applied for; and

Whereas, Dow is equipped to manufacture and transport such products and to supervise the treatment therewith of oil producing wells and provide facilities for such purposes; and

Whereas, Pure is a large producer of oil and other petroleum products and operates many producing wells in Michigan and various other states and has also been actively engaged in research work on the treatment of oil wells to increase production therefrom and has devised a new and novel process for the introduction of acid into wells and, for its protection in reference thereto, has obtained United States Letters Patent 1,891,667 entitled "Method of Facilitating the Flow of Wells"; and Pure has continued its research upon the treatment of oil wells and has made further discoveries and inventions and, for the issuance of patents thereon, applications are now pending; and

Whereas, in the treatment of its oil and gas wells Pure uses an inhibited acid known as Dowell-X and it is mutually desired that Dow shall continue as Pure's source of supply for its Dowell-X and other inhibited acids;

Now therefore, in consideration of the mutual covenants herein contained, the parties hereto agree as follows:

I.

Dow hereby grants unto Pure without royalty charge a non-exclusive license under Patent 1,877,504 and under any other patents which Dow may acquire, own or control, relating to acid treatment of oil or gas wells upon condition, however, that said license shall be limited and restricted in its use to the treatment by Pure of its own wells within Michigan.

II.

Pure hereby grants unto Dow, its subsidiaries and assigns, a license with right to sublicense others, exclusive except as to Pure, under Patent 1,891,667 and under any other patents which Pure may acquire, own or control during the existence of this agreement and relating to the acid treatment of oil or gas wells for the full term or terms of any such patent or patents. Dow shall pay unto Pure a royalty of five dollars for each and every well which shall be treated by Dow, its subsidiaries, sublicensees, agents or representatives after the execution of this contract; provided, however, that such royalty shall not apply to any wells treated by Pure. Dow shall keep proper records of the wells treated hereunder and within thirty days from the last day of each calendar quarter shall furnish to Pure a statement of the total number of wells treated in any such calendar quarter and at the same time account and pay over to Pure all royalties which shall have accrued for its account. Pure consents and agrees that if its Patent 1,891,667 shall be held invalid in whole or in substantial part by a court of last resort or by a court of competent jurisdiction from whose decision no appeal is taken within the time limit therefor, or if Dow shall discontinue the treatment of oil and gas wells, it may forthwith cancel and terminate this contract, any provision herein to the contrary notwithstanding. In event, however, that Dow shall sell to others its well treating business, any such sale shall be expressly subject to the provisions of this contract, and the assignee shall assume payment of royalties and all other covenants herein to be performed by Dow.

III.

Pure hereby acknowledges the validity of Dow's Patent 1,877,504, and Dow likewise acknowledges the validity of Pure's Patent 1,891,667. The parties mutually agree to cooperate with each other for the protection of the licensed patents with the understanding, however, that neither of

the parties shall be obligated to the other beyond furnishing, without charge, services of attorneys and other technical employees under general salary or retainer. Dow shall have the right at any time and from time to time to institute suit at law or in equity and to prosecute the same in its own name and/or in the name of Pure against any infringer of any patent owned or controlled by Pure pertaining to the acid treatment of oil or gas wells; provided, however, that no such suit shall be brought by Dow unless before instituting said suit Dow shall have first requested Pure to bring suit and Pure shall have neglected or refused so to do. Dow shall, in the absence of an agreement with Pure to the contrary, bring suit at its own expense and shall retain all damages or money awards therefrom.

IV.

Pure agrees that Dow or its subsidiaries shall have the first right or refusal to treat any and all wells of Pure outside of Michigan which Pure may desire to have treated, upon the basis of Dow's standard price for treating in such territory, less twenty per cent, less an additional $25 which represents royalty paid to Dow. In event Pure shall desire to treat its own wells in any territory outside of Michigan, Dow hereby authorizes it so to do upon condition, however, that it shall pay unto Dow a royalty of $25 for each and every well treated by Pure outside of Michigan.

V.

Dow hereby agrees to sell to Pure and Pure agrees to purchase and accept from Dow the merchandise herein described for a period of ten years from the date hereof (subject to certain limitations hereinafter recited) according to terms and conditions named below:

Article—Dowell-X, or other inhibited acids.

Quality—Same as now currently supplied by Dow to Pure, namely, 15% Acid Inhibited and/or 20% Acid Inhibited, as required by Pure.

Quantity—Pure's requirements for its own use only and not for resale, not exceeding 50,000 gallons per month. It is understood that this clause in no way limits Pure in the quantity of acid it may buy and use in the treatment of its oil and gas wells but is intended only to limit the quantity of acid which Dow may be required to deliver to Pure. In event Pure's requirements exceed 50,000 gallons per month, Dow shall be given the opportunity of supplying same at competitive prices and, in event of Dow's declining to so supply, Pure may purchase such excess requirements in the open market.

Package—Tank cars or containers furnished by Pure.

Price—(a) For such acid as Pure desires to take from Dow's plant at Midland, Michigan, the price shall be $50.00 per thousand gallons for the 15% acid inhibited and $68.35 per thousand gallons for the 20% acid inhibited, all prices f.o.b. plant, Midland, Michigan.

(b) For Pure's use at points distant from the Midland field where Dow has a supply of acid through arrangements with local producers of acid at such remote points, Dow will make it possible for Pure to secure such acid at the cost of raw acid to Dow, plus a reasonable price for the inhibitor used, if supplied by Dow, and plus a reasonable charge for compounding or diluting where Dow is equipped to and does so compound or dilute said acids.

Terms—One per cent ten days, thirty days net; payable in gold or its equivalent in United States currency.

Deliveries—Pure shall give Dow reasonable notice covering shipments and shall take deliveries in approximately equal monthly quantities.

It is agreed that upon Pure's written request other acid compounds may be substituted for Dowell-X, providing that such compounds are to be used in the treatment of oil and gas wells, and in such event suitable adjustments will be made and the price determined by the relative acid content in such other compounds as compared with Dowell-X, and shall be further corrected for greater or lesser cost involved in the manufacture.

It is mutually agreed that either of the parties hereto may terminate paragraph V of this agreement on the 31st day of December, 1937, or on the 31st day of December in any succeeding year, by giving written notice to the other at least sixty days prior to the date of cancellation.

Dow shall purchase at par Pure's holding of capital stock in Dowell Incorporated, that is to say, Dow shall pay Pure $5000 (less any dividends already paid thereon) for fifty shares of said capital stock. Dow shall promptly pay to Pure upon execution of this agreement all additional royalty which shall have accrued to Pure under the provisions of paragraph II of an agreement between the parties hereto dated January 31, 1933. It is further understood and agreed that this contract shall supersede and terminate the said agreement dated January 31, 1933.

Neither party shall be held responsible for any default occasioned by war, fire, strike, accident, civil or military authority, or other contingencies beyond its control.

In Witness Whereof the parties have caused these presents to be executed by their officers duly authorized on the day and year aforesaid, and have hereunto caused their respective corporate seals to be affixed.

The Dow Chemical Company
By Willard H. Dow, President.

Attest: James T. Pardee,
Secretary.

The Pure Oil Company
By R. Wm. Ilvane, Vice-President.

Attest: A. C. Harvey,
Asst. Secretary.

DEFENDANT'S EXHIBIT 8

REPORTS OF INVESTIGATIONS
DEPARTMENT OF THE INTERIOR—BUREAU OF MINES

Serial No. 2550, December, 1923

THE PARAFFIN PROBLEM IN OIL WELLS

By R. Van A. Mills[x]

[x]Petroleum engineer, Bureau of Mines, Department of the Interior.

Introduction.

This preliminary paper is intended to answer briefly some of the inquiries coming to the Bureau of Mines regarding the so-called "paraffining" of oil wells and methods of preventing and remedying that trouble. The increased difficulties in operation and the losses of production caused by the deposition of gummy and waxy hydrocarbons commonly called paraffin, in the wells, tubing, other pumping equipment, and in the pores of the productive sands, have long been recognized but the trouble has not been overcome. The nature and causes of the trouble, together with some of the possible methods by which it may be diminished or overcome, are outlined below.

Hydrochloric Acid. The Bureau of Mines has experimented with the use of hydrochloric acid following the treatment of a well with sodium peroxide. The purpose of this acid treatment was to dissolve calcium carbonate which, together with paraffin, plugged the pores of the sand around the walls of the hole. Several carboys of concentrated acid were dumped into the well by inverting the carboys on top of the open casing head, and allowing the acid to run down the casing. (A dump bailer might be used to keep the acid off the casing.) The acid was introduced after the sodium peroxide had stopped its violent reaction. The introduction of the hydrochloric acid which mixes with the sodium hydroxide resulting from the preceding reaction

gives another violent reaction with considerable heat. By adding an excess of acid, the calcium carbonate, silt, crusts, and interstitial matter is cleaned out by being dissolved. The acid may be permitted to stand in the well a few days but should then be bailed out together with loose sand, silt, and water.

DEFENDANT'S EXHIBIT 72

Prairie Depot, Ohio,
Dec. 5th, 1895

J. W. Van Dyke,
Lima
Dear Sir:

We were disappointed in getting away from Findlay on Tuesday morning and were detained there until Tuesday night. We arrived in Prairie Depot on Wednesday morning and I arranged with Mr. Gorden for some 1" tubing and told him to have same charged to you. We coated it with paint you had expressed here. Our tools and tubing were held in Fostoria from Monday night until on Wednesday morning when we came through there I saw them and as soon as I reached here I telegraphed for them and they were brought here on Wednesday P.M. The fact that the tools did not get here sooner has caused no delay on our part for they did not get the rig built in time to have the tubing pulled from the well before the afternoon of Wed-

nesday. I got our tubing and tools hauled to well on Wednesday evening and we tubed the well and got everything ready today to dump acid in the morning. The line to deliver water to the well is a temporary overground line and after we were all ready today we helped pumper to tear up, thaw out and relay the water line to make sure it would be so we could use it tomorrow. I sincerely hope to be through with this well in time to be in Lima Saturday night. I remain

Yours truly.
M. G. Harper

DEFENDANT'S EXHIBIT 73

Lima, O., Jan. 24, 1896

From Bluffton, Ind. 23 1896 No. 6792
To J. W. Van Dyke

Send man to Geneva tomorrow. Will meet him there noon train.

E. W. Harmon

Foned to Howard Nichols at 8:50 P.M.

Lima (Service)

Mime. 23 J. W. Van Dyke signed Harmon is Supt. Standard Rf. If he is not at home dely. to some one in charge his place.

Bluffton, Ind. 23

DEFENDANT'S EXHIBIT 74

Mr. J. W. Van Dyke

I herewith hand you all the written information about the acid wells which I have. There are some breaks in the gauges, the reasons for which I could not give now but you can get about the run of it from these telegrams. Sorry that I could not give it to you in a tabulated form but pressure of business prevents. After you are through with these would like them returned to me.

In haste,

C. F. Lufkin

DEFENDANT'S EXHIBIT 83

Lima, O., Nov. 25, 1895

From Findlay 25, 1895 No. 5790

To J. W. Van Dyke

Will be ready as soon as acid gets there.

J. C. Donnel

Notation.

Phoned C. F. Lufkin at 8:25 P.M.—Sat'y. 23"

DEFENDANT'S EXHIBIT 86

Lima, O., Dec. 6, 1895

From Prairie Depot 25 1895 No. 5984

To J. W. Van Dyke

All ready this evening. Will commence to dump acid early in morning.

M. G. Harper

DEFENDANT'S EXHIBIT 88

THE GRASSELLI CHEMICAL CO.
Cleveland, Ohio

July 26, 1895

Mr. J. W. Van Dyke
c/o Solar Refining Co.
Lima, O.

Dear Sir:

In reply to your favor of the 25th would say that we have had an interview with Mr. Frasch today and have decided to make you a price on Muriatic Acid of 85 cents delivered. This is the lowest price we are making any of our large consumers and is for delivery in carboys.

Should you be in position to use it in tank cars we could ship it to you in tank cars at 10 cts. per 100# less, but this would necessitate your drawing it off into carboys on arrival, at your own expense.

Hoping to receive orders from you soon, we remain,

Yours very truly,
The Grasselli Chemical Co.
per A. E. Whiting

DEFENDANT'S EXHIBIT 90

City, Sept. 22nd, 1895

Dear Van:

I did not get away this morning. Mrs. F. and Frieda are going at noon, and I am going to see them off. I will leave tonight and expect to be at the ——— Wednesday morning.

I saw Mr. Baily of the Grasselli Company, Mr. Grasselli not being home yet. They say Rob must have made a mistake as to the 16% business. He says it was 10 Baume, ought to have been 16° Baume in hot weather without deduction for temperature, but that it contained 27 or 28% acid. About the stronger acid it is made in cast-iron cylinders and contains less sulphuric, but is not as cheap. He no doubt would like us to use the 18° B. acid. I told him to let you know what they could do on stronger acid with less sulphuric. Price, etc. Write at once to Pittsburgh and see what the acid co. there can do. State we would use and are using large quantities. I enclose Hedrick's letter. I would not spend any money for the oil packing as it is not essential. The patents are good and strong. I will send him the money when I get back. I will also have the list of foreign ———. I think, however, that Canada is the only country we need take out a patent and we can do that any time. We have six months to do as we please. I will have to see Hedrick about that interference anyway. Then I will take the matter up and talk it over with him. Treat as many wells as you think best and do the best you can. Write or wire me if anything important turns up.

Good-bye.

Yours truly,

Herman

DEFENDANT'S EXHIBIT 101

Dec. 16, 1895.

Mr. J. W. Van Dyke,
Lima, O.

Dear Sir:

I suppose there should be a new string of tubing sent down to use on the Neeley well, as the one we have will be pretty well used by the time we get through on the Arnot well. We should have four new 1″ cocks also 4—1″ nut unions.

Yours respy.
M. G. Harper.

Mr. McCart. please to see to shipping the above and buy it charged to me.

J. W. V. D.

Mr. McCart: This 1″ pipe should have 2 coats of paint.

DEFENDANT'S EXHIBIT 102

Dec. 16th, 1895

Mr. J. W. Van Dyke,
Lima, O.

Dear Sir:

We were to the Arnot well today but have not made very satisfactory progress. Their tubing rope did not get to the well u..til in the afternoon and they did not have the proper amount of help to pull rods and tubing with and we helped them all afternoon.

We will not get to pour acid tomorrow. The Buckeye people have a duplex pump at the well which they have been using to run the oil from the well and I have gotten permission from them to use it in the treating of the well to pump the oil and water with. This well pumped 4½" of oil from Saturday morning at 7 o'clock until 12 o'clock on Saturday night and it done 9½" from 12 o'clock on Sunday night until noon today.

I got a piece of the rock from the well today which looks very promising. We will not be able to pour acid before Wednesday morning as we got nothing done today but to help them. We will have our pump to connect up, water lines to lay, and the well to tube tomorrow, besides helping them to pull balance of their tubing.

I remain respy. yours,

M. G. Harper

DEFENDANT'S EXHIBIT 103

THE OHIO RUBBER CO.
Cleveland, O.

Sept. 21, 1895.

Solar Refining Company,
Lima, Ohio.

Gentlemen:

Pursuant to our telephone conversation with your Mr. Frasch in regard to lining gas pipe with a rubber tube suitable to withstand hydrochloric acid, we have taken the matter up with our factory and asked them to advise us at an early date if they can do this work, also asking them for price per-foot for lining 1″ gas pipe with 1.8″ tube. As soon as we hear from our factory we will notify you immediately.

Yours very truly,
Ohio Rubber Company
G. N. Talcott

DEFENDANT'S EXHIBIT 104

THE OHIO RUBBER CO.

Cleveland, O., Sept. 25-1895.

Solar Refining Co.,
Lima, Ohio,

Gentlemen:

In regard to lining 1" gas pipe with rubber about which we wrote you recently, our factory reports that they think it will be a difficult matter to line this pipe so it will give you satisfaction. Gas pipe as you know is very dirty and sometimes greasy inside and any dirt or grease would of course have to be removed in order for the rubber to vulcanize to the iron. On so small a pipe as 1", it would be a difficult matter to clean it properly and we are in doubt whether we would be able to make the tube adhere to the iron. Another difficulty arises in coupling the gas pipe, you might loosen the tube at the end of the pipe where it was cemented allowing the acid to get in back of the rubber which would soon spoil the tube and we are of the opinion that we could not do you a satisfactory job. We would suggest that in place of gas pipe you use rubber hose, although we do not know under what conditions it would be used but we think a rubber hose would give you better service. Should you decide to put in rubber hose we would be pleased to figure with you.

Yours very truly,
Ohio Rubber Company
G. N. Talcott

DEFENDANT'S EXHIBIT 105

The Crossley well No. 3, owned by The Ohio Oil Co., located 1½ miles S. E. of Lima.

5⅝" casing, depth of well 1286 ft. 1/3 of a screw of loose sand, balance tight and hard.

Age of well when treated six months. Was shot after drilling in and the first 30 days did not produce gas and oil sufficient to make fuel to run and had to use wood. The records show the average daily production to be 1.6 barrels. From best information I can get the well was possibly doing one barrel per day before treating.

Commenced treating Aug. 5th; finished treating August 10, 1895.

DEFENDANT'S EXHIBIT 108

Prairie Depot, O., Feb. 5th, 1896

J. W. Van Dyke,
Lima, O.

Dear Sir:

We are strictly in the fishing business. We have been fishing until this P.M. about 3:30 o'clock trying to pick up a sand line which is in the hole and as yet we have failed to do so and we then abandoned the idea of getting a hold on the sand line and commenced putting ¾" tubing into the hole in hopes that we may be able to get to the bottom of hole and loosen up the tools and then the cable will bring the sand line up with it as we pull the tools out.

I saw Mr. Gordon this evening and he says the well (Mary Richard #1) still continues to make its 6" of oil each day. I have not been permitted to go out to see the well as yet, but will do so before I leave here.

I trust we may get tubing to bottom of hole and get the acid in tomorrow, but it is hard to say what progress will make tomorrow. The sand line seems to have fallen and bunched about 150 ft. from the top and we have been successful in getting 457 ft. of tubing in, which puts the bottom of tubing 307 ft. below where the sand line is fast in the hole.

Respy. yours,
M. G. Harper

DEFENDANT'S EXHIBIT 109

July 25, 1895.

Mr. C. F. Lufkin,
Ohio Oil Co.,
Lima, Ohio.

Dear Sir:

You will no doubt remember our conversation at your house last week, in reference to improving the flow of oil wells by the use of acid, and you will also remember, I presume, that at that time you thought you might, under certain conditions, furnish us one of your wells for trial.

If, after mature thought on this subject, you see sufficient possibility in this method to warrant your encouraging it, I would make the following proposition:

If you will furnish us a well comparatively new, reasonably free from salt water and in producing territory, by this I mean to convey to you that we want an oil well which there would be a chance of improving with our method; we do not want a dry hole, or a well in such a condition that nothing would improve it.

We will furnish the acid and pipe and place the acid in the well at our own expense. However, we would suppose you would remove the tubing and rods and re-tube, assuming you would prefer to do this. If we do not improve the well, then you are out only the expense of taking out your tubing and replacing it, and such other small costs as would naturally follow. On the other hand, if we improve the flow of the well sufficient to warrant your paying us for our material, then we would expect you to do so. As to this, you to be the judge.

The object of making this test would be to determine the merits of our method, therefore we would expect to have as far as possible the history of the well, its present production, and after the experiment has been tried to have free access and opportunity to see for ourselves if we have improved it.

Please consider this proposition, and if you believe there is enough in our method to warrant you in having same tried, please advise me with as little delay as possible, as I am getting quite anxious to bring this matter to a conclusion. On the other hand, should you not see any advantage to be gained to your interest by trying this, and should not wish to do so, please advise me.

It might be well to advise you that I have arrangements made for the acid, so the trial can be made without much delay.

Yours respectfully,
J. W. Van Dyke.

THE OHIO OIL COMPANY

Findlay, O., Feb. 13, 1896.

Mr. C. F. Lufkin,
Lima, Ohio.

Dear Sir: I herewith enclose you Mr. Van Dyke's bills and checks for the same as per your request of this morning. It seems to me that this is a most unreasonable charge for an experiment that Mr. Van Dyke expected to be benefitted by; he has figured in every possible item of expense that he was to in trying this experiment with these wells. The way the matter stands we have got a good deal of oil out of the Taylor well, in the 3 months since the well was treated I figure that we are ahead about 1500 barrels which would amount to about $1200. In addition to Mr. Van Dyke's bills we had to pump the well four at a cost of $110.00 a month for pumpers, we were compelled to get a string of tubing for the well at a cost of about $312.00 and also a string of big rods at an expense of about $78.00. This does not include a great deal of other labor we put on this well in addition to setting and furnishing a boiler and engine to pump the well.

The Cusac well we had to clean out after Mr. Van Dyke got through at an expense of about $50. This well

was not improved any, consequently we got no benefit from the experiment.

I enclose you a little Summary showing how we stand on the experiment to date.

Yours truly,

(Signed) J. C. Donnell

THE OHIO OIL COMPANY

Production, R. Crossley Farm:

June.	86.24
July	180.01
August.	194.43
September.	238.66
October	259.49
November	208.83
December	92.26
January.	148.37
8	1408.29
30	176.04
	5.87

THE OHIO OIL COMPANY

Lima, Ohio, February 22nd, 1896.

Mr. J. W. Van Dyke,
Gen'l Manager Solar Refinery.
Lima, Ohio.

Dear Sir:

Since talking with you this morning I have been examining your bill more critically and have made a little table of the cost of putting the acid in the wells. It develops some funny looking charges at least. First, the teaming is about twice as much for the Crossley well as any other

well, where the distance and roads were the shortest and best. Then Harper's charge for the Taylor well is the greatest where the acid went in the well with the least trouble. You will also see that Harper's time for the Crossley and the Cusac wells differs only twenty-one cents which at his rate would be for only five or six minutes, showing wonderful skill on his part in keeping time. The other labor is the *least* on the well on which Harper's time is the greatest, and his time would figure out at the rate of about $15.00 or $18.00 per day, which is pretty high.

These are a few of the most striking inconsistencies. I really believe, Van, that you can improve on this bill. Suppose you try it.

Yours truly,

M. C. F. Lufkin

THE OHIO OIL COMPANY

Extra Pumpers at Taylor well (3 months at $110.00)		$ 330.00
String of 3 inch tubing at Taylor well		312.00
String of big rods for Taylor well		78.00
Cleaning out Cusac well		50.00
J. W. Van Dyke bill for Taylor well		357.21
J. W. Van Dyke bill for Cusac well		391.78
Amount ahead account Taylor well	$1200.00	
	$1200.00	$1518.99

THE OHIO OIL CO.

Lima, Ohio, February 25th, 1896.

Messrs. J. W. Van Dyke & Herman Frasch,
Lima, Ohio.

Gentlemen:

Herewith you will please find three checks of The Ohio Oil Company amounting to one thousand three hundred and ninety-three dollars and eighty-two cents, ($1393.82), in

payment of the four vouchers enclosed, which you will please sign and return to me. What may appear like a seeming delay to you has arisen wholly from the fact that the wells were located in different parts of the Field under different Division Superintendents, and that our General Manager, Mr. William Fleming had requested to see the bills before they were paid; all of which has been done as expeditiously as possible, when all the circumstances connected with the matter are considered.

Yours truly,
C. F. Lufkin
General Superintendent.

DEFENDANT'S EXHIBIT 110

THE OHIO OIL CO.

Lima, Ohio., July 29th, 1895.

J. W. Van Dyke, Gen. Mgr.,
The Solar Refining Co.,
Lima, Ohio.

Dear Sir:—

Replying to yours of the 25th, containing a proposition to introduce acid into an oil well owned by The Ohio Oil Company, for the purpose of increasing the production of oil, I beg to say; that the conditions you impose are satisfactory as far as they go, but to avoid any misunderstanding, I will make a counter proposition as follows:

Defendant's Exhibit 110

The Ohio Oil Company will furnish you an oil well in some part of the Lima field which has been torpedoed and is producing oil in paying quantities. We will allow you access to the well, and give you any information we have concerning it, before the acid is introduced, and also afterwards, so that you may be able to form your own estimates of its production. You are to furnish the acid for and introduce it into the well at your own expense; and after it has remained sufficiently long to do the work which you desire it to accomplish, if the well is found to be filled up with sediment, caused by introducing the acid, you are at your own expense to furnish tools and men to clean the well out, and remove all the sediment to its original depth.

The Ohio Oil Company will remove the tubing and rods and replace the same at their expense.

At the end of thirty days, after the well has been put to pumping in a successful way, if the production has been sufficiently increased to warrant the Ohio Oil Company's reimbursing you for the cost of the acid at the well, also the cost of cleaning the well out, The Ohio Oil Co. will pay you such costs; The Ohio Oil Company to be the judge, whether the production has been sufficiently increased to warrant such payment.

I have in mind now, a well located on the Crossley farm, about three miles east of this city; it is only a month or six weeks old, and a fair producer: I cannot now state its amount, but feel sure that you will be satisfied with its location, and surroundings, and the opportunity it will afford you of determining the merits of your method of increasing the production of oil wells.

A copy of the above will be furnished William Fleming, our General Manager, and will be subject to his approval.

Very truly yours,
C. F. Lufkin.

DEFENDANT'S EXHIBIT 111

Dec. 2nd, 1895

J. W. Van Dyke,
Lima, Ohio
Dear Sir:

Mr. Angel says to tell you they (The Walker Oil Co.) have 4 wells near Helena, (one of them being the well I spoke to you about over the phone) which they will want acid in if it proves satisfactory on the first one. They are wells that started off at from 35 to 50 barrels and have now fallen away to from 5 to 8 barrels. The 4 wells he tells me do about 10 barrels of water in a week. They are situated close together and are pumped with shackle rods. The haul from R.R. to wells is about one mile. The distance the wells are in sand is about 60 ft. with a total depth of about 1300 ft. As regards the pay for the well I told him I thought you would take the increased production until the job was paid for, which he considered very reasonable, but also spoke of paying for it on the 30-60 and 90 day plan which I told him would be satisfactory to you I thought. He wanted me to set a price on treating one well to which I replied that it would be very near $500.00.

I made no decisive answer thus leaving room for you to make it higher if I am too low. He said he would like you to write him concerning the well. His address is C. B. Angel, Findlay, Ohio.

I remain yours truly,
M. G. Harper

DEFENDANT'S EXHIBIT 112

THE GRASSELLI CHEMICAL CO.
Cleveland, Ohio

Nov. 21st, 1895

Mr. J. W. Van Dyke,
Lima, Ohio.

Dear Sir:

We shipped yesterday car 7762 D consigned to Findlay —we have asked the L. S. & M. S. to trace it and they tell us that it will arrive at Findlay tomorrow.

Car 15902 N. Y. C. & St. L. was pulled out of our yard today consigned to Prairie Depot.

The N. Y. C. & St. L. people will trace it and we will advise you tomorrow when delivery will be made.

Yours truly,
The Grasselli Chemical Co.
(Signed) A. E. Whiting

DEFENDANT'S EXHIBIT 113

THE SOLAR REFINING COMPANY

Lima, Ohio, Nov. 20, 1895.

Grasselli Chemical Co.,
Cleveland, O.

Gentlemen:—In reference to our order dated Nov. 19th for a car load of hydro-chloric acid to be shipped to Prairie Depot, and one to Findlay, Ohio, we telegraphed you today as follows:

"Change our order of yesterday shipping first car to Findlay."

We found it necessary to make this change, as we wish to treat the well at Findlay first, then follow with the well at Prairie Depot.

In both cases we want you to ship large cars. Would ask that you rush the shipment to Findlay and follow with tracer, then follow with the shipment to Prairie Depot as soon after as you can, advising me what time we can expect the cars to arrive at the different places.

Yours truly,
J. W. Van Dyke

DEFENDANT'S EXHIBIT 114

Nov. 21, 1895

Mr. Harper starts tomorrow morning for Findlay to treat the Cusic well belonging to the Ohio Oil Co. 4 miles west of Findlay. He then goes to Prairie Depot and there treats a well, that is not yet named, for the Ohio Oil Co. I give Mr. Harper $125 in cash. The acid was shipped in his name. Mr. Harper stops at the American House in Findlay.

DEFENDANT'S EXHIBIT 115

Dear Van:

I am going South tonight to see the rubber people. They will write you about the pipe. They say they can coat it outside and inside. I have an engagement with the Grasselli now. I obtained a letter from Hedrick that our patents are allowed. We better let that rest till I return. I just received word from N. Y. that I could go. About wells use your judgment. Good bye and will write again.

H. Frasch

DEFENDANT'S EXHIBIT 132

THE GRASSELLI CHEMICAL CO.
Cleveland, Ohio

Mr. J. W. Van Dyke, July 19, 1895.
Gen. Mgr. Solar Refining Co.
Lima, Ohio

Dear Sir:

Your esteemed favor of the 17th, addressed to our President, Mr. C. A. Grasselli, came duly to hand, but regret to say that he is out of the city and will be for some days. Would suggest, however, that if you will require any Hydrochloric Acid in the meantime, to forward us the orders and the price can be adjusted on Mr. Grasselli's return.

Your request as to treating the subject confidentially shall certainly be complied with.

Yours very truly,
The Grasselli Chemical Co.
H. C. Grant

DEFENDANT'S EXHIBIT 138

THE OHIO OIL CO.

Lima, Ohio,
August 2nd, 1895

J. W. Van Dyke, Gen'l Manager,
The Solar Ref'n'g Co.,
Lima, Ohio.

Gentlemen:—

Replying to your telegram of today, will enclose you a copy of our record of the well in which you are anticipating introducing acid. The well is known as the No. 3 R. Crossley "fee," and has 5⅝ casing. We cannot tell the depth of the "oil bearing rock," as you term it, because the writer does not know of any such thing. Any kind of sand as far as can be judged after being "drilled up" may, or may not, produce oil; therefore, we never note anything but the point at which the wells make their show of oil gas or water.

Very truly yours,
C. F. Lufkin

DEFENDANT'S EXHIBIT 151

Report on Scale Formation in Wells. By Blaine B. Wescott. Research Project Ch-17. Research Laboratory, Gulf Oil Companies, Mellon Institute, Pittsburgh, Pennsylvania.

Contents

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Scale Formulation in Wells, by Blaine B. Wescott.

Purpose.

The investigation of the formation of scale deposits in wells (Research Project Ch-17) was undertaken at the request of Mr. C. P. Dimit, production superintendent of the Gypsy Oil Company. The investigation applies particularly to wells in the Glenn Pool where the scale deposition has been more or less general in many of the wells. The purposes of the investigation were to determine the cause of the deposition, to find a method for its removal and to ascertain whether the formation of the scale could be prevented. The first two objectives have been accomplished; the third is still a matter for study at the present time.

Description of Samples.

The samples listed in Table 1 were submitted by Mr. Dimit in connection with this problem.

Table 1.

Description of Samples.

Sample No.	Description.
425	Scale from the outside of the 19th joint of tubing from Jennie Spocogee Well No. 5, in the north extension of the Glenn Pool in Section 17, Township 18 North, Range 12 East, Map No. 31.
426	Scale from the inside of the same joint of tubing described under No. 425.
427	Water from Lease Well J. Anderson 1, Glenn Pool, Section 9, Township 17, Range 12, 1-17-28. Pumping.
428	Water from Lease Well J. Anderson 2, Glenn Pool, Section 9, Township 17, Range 12, 1-20-28. Pumping.
429	Water from Lease Well A. Y. Barnes No. 2, S. E., N. E., N. W., Section 8, Township 17, Range 12, 1-19-28.
430	Water from Lease Well J. P. Rhodes No. 6, N. W., N. W., N. W., Section 21, Township 17, Range 12, 1-18-28.

The sample of tubing from the Jennie Spocogee Well No. 5 was very heavily scaled on the outside and more lightly scaled inside. The well ceased to produce about three years ago, apparently because of tubing trouble. The tubing could not be removed by the usual methods. Since the well was a small producer, removal of the tubing was delayed until November 29, 1927. It was necessary to pull the tubing until it parted and then fish it out by sections. In this case it was found that the tubing was scaled about uniformly for 420 feet from the bottom. Figures 1 and 2 were taken from the 19th joint of tubing from this well showing the extent of the scaling.

Water Analyses.

The analyses of the water samples are given in Table 2.



Figure 1.

Scale deposit on the outside of the 19th joint of tubing from Jennie Spocogee Well No. 5, Glenn Pool. Scale was chipped off at the top to show the thickness of the deposit.



Figure 2.

Cross sectional view of scale deposits on the 19th joint of tubing from the Jennie Spocogee Well No. 5, Glenn Pool, showing scale deposits on both inside and outside of the pipe.

Table 2.

Analyses of Water Samples From Wells in Glenn Pool.

Sample No.	427	428	429	430
Well	J. Anderson No. 1	J. Anderson No. 2	A. Y. Barnes No. 2	J. P. Rhodes No. 6
Constituent	Amount in grams per U. S. gallon.			
Total dissolved solids	7543.2	7370.7	7310.6	7899.0
Suspended matter	29.7	21.0	21.6	17.1
Calcium bicarbonate ($CaCO_3$)	6.2	11.2	12.8	24.0
Magnesium bicarbonate ($MgCO_3$)	nil	nil	nil	nil
Calcium sulfate ($CaSO_4$)	nil	nil	nil	nil
Magnesium sulfate ($MgSO_4$)	nil	nil	nil	nil
Sodium sulfate (Na_2SO_4)	7.3	6.4	7.3	5.7
Calcium chloride ($CaCl_2$)	803.0	772.0	753.0	775.0
Magnesium chloride ($MgCl_2$)	417.0	493.0	527.0	638.0
Strontium chloride ($SrCl_2$)	75.0	84.0	36.0	73.0
Sodium chloride ($NaCl$)	6230.0	6090.0	5970.0	6380.0
Iron and alumina (R_2O_3)	3.8	3.1	3.4	2.6
Silica (SiO_2)	0.9	1.0	1.1	0.7

The analyses showed the water to be a brine high in calcium bicarbonate, a constituent causing temporary hardness. The amounts of this substance present were high in all the samples excepting No. 427. It is probable that the other three samples were more nearly representative of the general conditions throughout the field than No. 427 containing the lesser amount of calcium bicarbonate. Large amounts of calcium bicarbonate are held in solution by means of the carbon dioxide present. A release of pressure

such as would occur when the water enters a well cavity would allow the carbon dioxide to escape and would be accompanied by the subsequent precipitation of calcium carbonate. There is no doubt that these facts explain the heavy scale deposition in the wells of this field.

Scale Analyses

The analyses of the samples of scale are given in Table 3.

Table 3.

Analyses of Samples of Scale From 19th Joint of Tubing From Jennie Spocogee Well No. 5.

Sample No.	425	426
Location	Scale from outside of tubing.	Scale from inside of tubing.
Oil	20.85%	1.19
Organic matter and water	2.52	0.95
Iron and aluminum oxides	3.01	5.52
Calcium carbonate	70.63	81.88
Magnesium carbonate	2.85	10.89

The composition of the scales substantiated the conclusion reached from the water analyses, namely, the scale deposition was caused by the release of pressure on a highly carbonated water.

Some previous work on scales from wells in the Glenn Pool indicated the presence of large amounts of strontium carbonate. For this reason special attention was given to the determination of strontium in both the waters and scales. The results of the strontium analyses in the water samples are given in Table 2. This work showed without doubt that the strontium in the water samples was present in the form of strontium chloride, a freely soluble salt, and therefore, the presence of this salt in no way affected the scale deposition and furthermore, any strontium present in the scale was due to occlusion of the salt by the scale.

Again, this conclusion was substantiated by the analyses of the scale samples for strontium which are given in Table 4.

Table 4.

Results of Analyses for Strontium in Samples of Scale from Jennie Spocogee Well No. 5.

Sample No.	425	426
Location	Scale from outside of tubing	Scale from inside of tubing
Strontium oxide	0.33%	0.12%
Corresponding percentage of strontium chloride	0.50	0.18

The insignificant amounts of strontium found undoubtedly point to occlusion of the chloride by the scale. The presence of such quantities of strontium is nothing unusual. The element is very closely related to calcium in its chemical properties and in ordinary analytical procedures is separated with and reported as part of the calcium content.

A complete analysis of the scale for chlorides, sulfates, etc., was not necessary since the problem was to find a solvent for the deposit. The amount of strontium reported in Table 4 appears as part of the calcium in Table 3. The results in Table 3 were not corrected for this constituent because, as just stated, a complete analysis was not necessary in order to determine a solvent for the scale, and because it has no bearing whatever on the purpose of this investigation as shown by the water analyses.

Removal of the Scale.

Since the scale was shown to consist mainly of calcium and magesium carbonates, the selection of a solvent was a simple matter. The scale was easily soluble in all mineral acids but the most suitable one was hydrochloric acid be-

cause the products of the reaction of the scale and hydrochloric acid are all soluble and offer no difficulty of removal. The use of an acid in removing the scale involves the loss of some of the metal of the tubing, casing and sucker rods by solution in the acid. The casing in the Glenn Pool field is old and probably more or less severely corroded in spots. The corrosion in areas subjected to scale deposition is probably slight as the scale forms a very efficient protective coating. There are available on the market, numerous patented materials called inhibitors which are used principally in the commercial pickling of iron and steel products to reduce the loss of metal by solution in the acid. Some of these materials are very efficient in their action in dilute acids. Among the most successful of the inhibitors are a series of materials called Rodines, manufactured by the American Chemical Paint Company, of Ambler, Pa. Experiments were made with the two Rodines made by this company which were most nearly suited for the protection of the ferrous materials in the wells in the presence of concentrated hydrochloric acid, namely, Rodine No. 2 and Rodine No. 106. Both Rodines are patented products so that accurate information regarding their composition is not available. Rodine No. 2 is a liquid, the base of which is waste sulfite liquor from the paper industry with additions of certain anthracene compounds. The Rodine No. 106 is a powdered material with thiourea as its base. Half sections of tubing about one-half inch in width were cut from the sample of the 19th joint of tubing from the Jennie Spocogee No. 5 well. The sections were pickled free of rust and scale, washed, dried and weighed. They were then immersed in concentrated hydrochloric acid with varying percentages of the two inhibitors. After remaining in contact with the acid for at least 48 hours at room temperature and 6 hours at 125° F. the pieces were washed, dried and reweighed. The results are given in Table 5.

Table 5.

Effect of Inhibitors on the Action of Concentrated Hydrochloric Acid on Steel Pipe.

Temperature of Test F°	*Hours Immersed*	*Inhibitor*	*Amount of Inhibitor Used*	*Per Cent Loss in Weight*	*Approximate Loss in Weight in Grams Per Sq. Inch of Surface Per Hour Immersed*
125°	7	None	——	57.2	0.638
125°	7	Rodine No. 2	2%	3.3	0.037
Room	72	None	——	86.4	0.094
Room	72	Rodine No. 2	2%	12.5	0.0136
Room	48	Rodine No. 2	3%	1.4	0.0023
Room	48	Rodine No. 2	4%	0.7	0.0011
Room	48	Rodine No. 106	1 lb./10 gal. of acid	5.6	0.0092
Room	48	Rodine No. 106	1 lb./5 gal. of acid	3.3	0.0054
Room	48	Rodine No. 106	1 lb./2½ gal. of acid	1.4	0.0022

The losses in weight in grams per square inch of surface exposed per hour (figures in the last column of the table), afford a direct comparison of the protection afforded to the metal in the respective tests. The greatest protection was given by the use of 4 per cent of Rodine No. 2 by volume of acid. This protection was just twice as great as that given by the use of Rodine No. 106 in the proportion of 1 pound to every 2½ gallons of acid used. There is no doubt that for the purpose at hand that Rodine No. 2 will prove most suitable. It not only affords greater protection but is much easier to handle since it is a liquid.

The results given in Table 5 indicate that perfect protection to the steel could most probably be insured by the use of sufficient Rodine. It would not be economical to do that however. Furthermore, the results in the table are considerably higher than those that would actually be met with in practice because of the dilution of the acid by fluid

material in the wells. The losses represented by the use of 4% of Rodine No. 2 were nearly negligible.

Theory of Inhibitors.

The commercial use of inhibitors for the protection of metals in acid solutions is not new. A very great number of substances have been studied for their inhibitive value; some have been good, others worthless. There has been no definite relation indicated between chemical properties and inhibitory value. The mechanism of the inhibitive action is very little understood. Some inhibitors are colloidal in nature and it has been noticed that the over-voltages at anode and cathode in acid is increased proportionally to the colloid concentration. Some substances, such as formaldehyde and quinoline ethiodide exert powerful inhibitory action when only very small amounts are present, suggesting that the effect is catalytic in nature. It has also been suggested that the inhibitor forms some sort of film over the cathode which acts to prevent the ready evolution of hydrogen. The most recent explanation advanced for the action is as follows:

Iron immersed in acid goes into solution at the anode areas, forming iron ions in solution and depositing an equivalent amount of hydrogen ions at the cathodic areas. These cathodic areas are assumed to occur principally in the grain boundaries of the crystals in steel or at the interface of slag and iron in wrought iron. Most inhibitors are either organic bases or positively charged colloids, and when these are present, they travel to the cathode areas with the hydrogen. When the positively charged heavy particles of the inhibitor are discharged at the cathodes, they cannot escape by gaseous evolution, and accordingly are absorbed on the surface building up a protective layer.

Estimated Cost of Scale Removal

The cost of Rodine No. 2 is as follows:

Table 6.

Cost of Rodine No. 2.

In 10 gallon drums	$2.50 per gallon
In 52 gallon drums	3.25 per gallon
In lots of 10 or more 52 gallon drums per year	3.00 per gallon

Rodine No. 106 varies in cost between $0.35 and $0.40 per pound depending upon the amount purchased.

The prices for commercial hydrochloric (muriatic) acid in less than carload lots in carboys F. O. F. Pittsburgh are as follows:

Table 7.

Cost of Hydrochloric Acid.

No. of carboys	Cost per 100 lb.	Cost per carboy	Cost per gallon
1 to 4	$1.95	$2.24	$0.224
5 to 9	1.85	2.13	0.213
10 to 20	1.75	2.01	0.201
20 and over	1.65	1.90	0.190

Note: 1 carboy=115 pounds=10 gallons.

Assuming the purchase of hydrochloric acid in lots of 20 or more carboys and the purchase of Rodine No. 2 in 52 gallon drums, the total costs for materials per gallon of acid used for a 4% solution of Rodine would be $0.32. The actual cost in the field would be somewhat greater since the acid prices given were F. O. B. Pittsburgh and the Rodine prices F. O. B. Ambler, Pa.

The estimate given below as to the amount of acid required for one well was furnished by Mr. Sommers, of the Geological Department upon the following assumptions,

which he considered to be average for the field as judged from the available information:

1. 6⅝ inch casing string to within 300 feet of the bottom of the hole.
2. 275 feet of about 6½ inch open hole below tubing.
3. 25 feet of about 12 inch open hole resulting from shooting with 40 quarts of nitroglycerine.
4. For filling 6⅝ inch casing it requires about 1/25 barrel per foot.
5. 1 barrel=6.2 (5.6) cubic feet=42 gallons.

Assuming the casing is to be filled for 300 feet the acid required would be approximately 1092 gallons. This would require 44 gallons of Rodine for a 4% solution. The total material cost would then be $350. This estimate, as can be readily seen, is based upon very indefinite and general information and a much more accurate figure could be arrived at by taking data for a definite trial well.

Method for Scale Removal.

In the use of hydrochloric acid and Rodine No. 2 in dissolving the scale from the casing and tubing in the wells, the proper amount of Rodine should be added to each carboy of acid and the two liquids well mixed by shaking the carboy before the acid is poured into the well. For a 4% solution the amount of Rodine No. 2 required per carboy would be roughly 3½ pints. The estimated quantity of mixed acid would then be poured into the well both down the tubing and down the casing. It is not possible to estimate the time required since that would depend almost entirely upon the surface of scale exposed to the acid. The acid could be allowed to remain in the well for several days without danger to the tubing and casing. When solution of the scale is judged to be complete the well should be well washed with water and the spent acid and washings discarded.

The amount of acid required to dissolve any given amount of scale could be readily calculated but the figure

would have but little value since the thickness and height of the deposits would be unknown unless the tubing were withdrawn, in which case the scale could be knocked off easily and at a fraction of the cost required to dissolve off.

Great care must be exercised in handling the acid in order to avoid burns and destruction of clothing.

Prevention of Scale Formation.

The necessity for removal of the scale in wells suggests the possibility of preventing its formation. It is very probable that the formation of scale could be materially decreased or prevented entirely by the use of sufficient amounts of sodium bicarbonate. The addition of sodium bicarbonate to waters containing high amounts of calcium bicarbonate prevents the deposition of calcium carbonate even at comparatively high temperatures. The action is the result of the introduction of the common bicarbonate ion into the solution which prevents the reaction resulting in the precipitation of calcium carbonate from going to completion.

The feasibility of such a procedure is doubtful, however, because of the probable expense and the difficulty in properly mixing the water and chemical. Constant treatment of large amounts of water would be necessary. If the liquid between the tubing and casing did not change rapidly the treatment would be much less expensive. The rate of change of fluid between casing and tubing could be determined by introduction of a suitable dye between the tubing and casing and noting the time before its appearance from the tubing. Such a test would furnish the necessary information for determining whether water treatment could be economically used. Periodical removal of the scale either with acid or by removal and cleaning of the tubing would probably involve much less expense.

The suggestion was advanced by Mr. Weaver, of the Geological Department, that since the wells in this field are pumped by vacuum lift, there is a possibility of air leakage

into the producing sand through some well. Such a leak, if of any magnitude, would cause the introduction of large amounts of carbon dioxide into the sand and might result in the solution of large amounts of calcium bicarbonate which would later be precipitated in some other well upon release of pressure, with the accompanying liberation of the carbon dioxide. Such a possibility is worthy of investigation. However, it seems more likely that the carbon dioxide either originally existed in the field or is being produced by oxidation processes occurring in the ground. The present report is primarily concerned with the means for removal of the scale, but the fundamental source of the carbon dioxide, responsible for the scale, is a problem to which attention will be given at a later date. It is certainly of academic interest and may have an important practical bearing.

Conclusions.

The following conclusions were reached in this investigation:

1. The scale deposited upon the tubing and casing in the wells of Glenn Pool consists principally of the carbonates of calcium and magnesium.
2. The deposition of the scale is the result of the high temporary hardness content (calcium and magnesium bicarbonates) of the oil field water in that area. The passage of water from the sand to the well is accompanied by a release of pressure allowing the escape of carbon dioxide which causes the deposition of calcium and magnesium carbonates.
3. The only economically available solvent for the scale is hydrochloric (muriatic) acid.
4. Hydrochloric acid treated with a sufficient amount of a suitable inhibitor may be used without fear of damage to sucker rods, tubing, casing or other ferrous materials in the well.
5. Rodine No. 2 (or other Rodines having like inhibitive value) used in the proportion of 3% to 5% by volume of

acid affords ample protection to the ferrous materials in the wells.

6. It is doubtful whether the scale could economically be prevented from forming. Preventive measures would involve the continual treatment of the water in the wells with sodium bicarbonate.
7. The feasibility of the water treatment method would depend upon the outcome of tests made to determine the rate of change of water in the wells between tubing and casing. Such tests could be rather easily carried out by the introduction of a suitable dye (fluorescein) into the well outside of the tubing and noting the time and fluid production of the well between the time of introduction and time of its appearance.
8. The release of pressure probably occurs at the surface of the sand in the well cavity, in which case it is reasonable to suppose deposition of more or less of the scale on the surface of the sand. Therefore, the trial would be well worth the expense for its possible value in increasing the production of the well entirely aside from the object of removing the scale from the pipe.

Recommendation.

I recommend that the removal of the scale by use of hydrochloric acid and 4% of Rodine No. 2 or other inhibitor of equal effectiveness be tried in one well of the Glenn Pool.

DEFENDANT'S EXHIBIT 152

Production Department, Engineering Report.

Tulsa, Okla., February 1, 1929.

Subject: Gyp Treatment at Glenn Pool.
Assignment No. 38. Written by F. W. Karl.
Consulting Eng., D. L. Trax.
Production Eng., R. L. Wright.

William Berryhill No. 8 was selected for the experiments on scale removal as outlined in our previous reports of August 24th, and September 14th, 1928, the well having been off production because of "gyped" tubing in March, July, September and November, 1928. A device was constructed for lubricating the acid and inhibitor into the well between the tubing and casing without releasing the vacuum.

On November 12th, nine carboys of hydrochloric acid, approximately 1,000 pounds, and the necessary rodine to give a four per cent by volume mixture, were lubricated into the casing of the well. The following day the well failed to pump and the tubing was pulled. The Penrod and Thompson barrel was removed and a common barrel substituted. One and one-half carboys of acid and the proper amount of inhibitor were poured down the tubing and Hough liner barrel run in on the rods. Considerable difficulty was experienced in getting the barrel down through the tubing, it being necessary to lift and drop the rods several times to force the barrel through the deposits on the tubing. After the barrel was seated, one and one-half carboys of acid and inhibitors were added partly to fill the tubing. The well was allowed to stand one day and then pumped. Samples of the fluid showed no free water. This seemed to indicate that insufficient acid had been used and an additional five carboys of acid were run in between tubing and casing. The well was allowed to stand a day and then pumped. No free water was produced but on extrac-

tion of the fluid with distilled water a distinct acid reaction was obtained.

Since the acid treatment was applied the well has pumped satisfactorily but the production has not been increased. No pulling jobs have been necessary for "gyp" trouble but the time has been too short to draw any definite conclusions as to the effectiveness of the treatment.

FWK:HG F. W. Karl.

DEFENDANT'S EXHIBIT 153

Same as Plaintiff's Exhibit 153. (See pages 1664 to 1704.)

DEFENDANT'S EXHIBIT 287

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	6	AA	141	93	7- 7-41

DEFENDANT'S EXHIBIT 300

$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$
100 + 72
1 barrel 20% acid HCl 42 Gallons

42. x 3.78 x 1100 x 20% = 34,920 gms. HCl

$\frac{34,920}{72} = 486 \times 100 = 48,600$

$\frac{48,600}{454} = \frac{107\#}{-}$ $CaCO_3 - 298 = 3.0$

107# C.P. $CaCO_3$

3) 48,600
16,200 C.C.

16.2 x .035 = .567 cu. ft. $CaCO_3$ C. P.

DEFENDANT'S EXHIBIT 301

THE PURE OIL COMPANY

Chicago, December 1st, 1932.

The Dow Chemical Company,
Midland, Michigan.

Attention Mr. Dow.

Gentlemen:

Absence from the office of the writer and others with whom it was necessary to discuss the matter, has delayed reply to your letter of November 5th relating to the patent situation involved in the acid treating process which we discussed fully on the occasion of our recent conferences in your office.

In your letter you have merely reiterated the contentions made by you and your representatives to us, without giving weight or what we feel is due consideration to the representations made by us to you. We have attempted in our various conversations to give you what we think is the picture and history covering this entire transaction. You have been given another picture by employees of your company with which we do not agree in any particular. Certain statements were made to us about conversations had between our Messrs. Humphrey and Thomas, and your Messrs. Grebe and Sanford, which we felt were erroneous, and in order to clear up the matter and establish a better understanding of what actually transpired, we suggested and you agreed that we bring Messrs. Thomas and Humphrey to Midland and have them and the two gentlemen from your organization give us and you their version of what was said by each, and when. We had Mr. Humphrey come from Chicago and Mr. Thomas from Saginaw, and we presented them to you, but were informed by your attorney that for certain reasons it was not considered advisable at that time to proceed with that phase of the investigation.

We stated to you then and we reiterate now, that it is our firm conviction that if the idea of treating oil wells with acid, or any process used in connection therewith, is patentable, that The Pure Oil Company, being the inventor, is entitled to any such patent. So far as Dow is concerned, the only way it ever became involved with us in this picture was as a source of supply of the acid we required in making the original experiment and further supplying acid to us at a price thereafter. The first conversation ever had between any representative of Dow and any representative of Pure, concerning this matter, was when our Mr. Thomas called at your office in Saginaw for the purpose of determining whether or not Dow could or would supply us with acid to make this test. The question of an inhibitor was raised at this first discussion and your Mr. Grebe advised Mr. Thomas that an inhibitor could be supplied by Dow. It was our information that at times in its regular operations it was necessary for Dow to make a considerable amount of Hydrochloric Acid above its current requirements, and that at such times it was in a sense a waste product. Your company was glad to furnish us with the acid free of cost for the initial test, because if it proved to be successful, as we had every reason to believe it would, it would afford a ready market for this product. This is somewhat in line with your own statement to the writer at your home, when you said that when Dow first went into the matter it was with the idea of creating a market for the acid, and that later, in order to restrict competition and protect this market, you felt called upon to apply for patent.

Your company did deliver the first acid to the well location, but our own employees did the actual work of introducing the acid into the well. Your company asked permission to have a man present on the well, which was granted, and your representative who was permitted to witness the test was cautioned by our Mr. Humphrey to treat this matter in the strictest confidence. This request was made both of Mr. Sanford and Mr. Grebe. This was done under specific instructions from the management of this company.

When our Mr. Thomas called at your office in Midland for the purpose of ascertaining whether or not you could or would furnish the acid for this work, he was referred to your Mr. Grebe. After Mr. Thomas had explained the purpose of his call, Mr. Grebe advised that the acid would be supplied but that he doubted whether it would work, since Dow had made some kind of an experiment on one of its brine wells producing from the Marshall sand and the experiment had been a failure. I mention this in connection with your statements that it was necessary for Dow representatives to sell this idea to Pure's representatives. You have stressed this point at different times and in your letter, even in the face of our statements to you that this was not the fact, and it now becomes my duty to again advise you that this matter was worked out in our own laboratory before Dow ever heard anything about it from us, and the only reason that Dow ever came into the picture, so far as we are concerned, was, as before stated, because they were manufacturing a product required by us in this work and were conveniently located to our operations. This was one of the points we had hoped to clear up in your mind when we brought Messrs. Thomas and Humphrey to your office in Midland.

You have further stressed the fact that Pure did not question Dow's claim to invention of the use of an inhibited acid in connection with this work, until long after the filing of application and issuance of patent to Dow. The fact is that we called on you very shortly after the issuance and publication of the patent to you. This was our first information that Dow was interfering with what we claim is our invention, to the point of seeking a patent covering it, and frankly, it was quite a surprise to us, knowing as we did what part Dow played in this undertaking. As to the use of an inhibited acid, we went into this quite fully with you in our various conversations. The inhibitor plays no part whatever in the treatment of the oil producing formation, its only function being to protect the equipment at or in the hole, or used in transporting acid to location. The

use of an inhibitor in an acid to protect a metallic substance against attack from the acid itself, is admittedly not new. This is the only function of the inhibitor in acid for oil well treatment. As we advised you, in our original study of this matter this factor had been considered and given full weight before anyone from The Pure Oil Company ever approached Dow in connection with the matter.

In your letter you mention a number of significant factors, but the writer cannot escape the conclusion that the most significant factor in the whole picture is this one fact: For the sake of illustrating this point, without admitting but specifically denying the correctness of the statements and claims made by Dow, it is quite significant that with oil wells producing from lime formations in Michigan for several years, almost within sight of Dow's main plant and from properties on which Dow has brine wells producing, so far as the writer knows Dow never at any time made any experiment on any oil producing well or suggested any such experiment to anyone else, nor did it file any application for patent until after it had been approached by Pure and Pure had made the tests, determined the practicability of acid treatment of lime wells, and made it operative and a commercial success.

You mention the fact that Dow has established a service of wide scope, offering not only acid treatment but a variety of well treatments of interest and value to the oil producer. For the moment we are not interested in the well service other than acid treatment, which is the subject matter of this communication.

Based on past relations we have every confidence in the fairness and integrity of your organization and feel that the present controversy is due to misinformation in connection with the origin of the acid treatment process as between our two companies, and that when this is cleared up there will be no trouble in arriving at a fair and equitable settlement of this dispute, however, we cannot agree that the suggestion contained in your letter of November 5th is a fair basis of negotiating an adjustment.

Yours very truly,

CP-F. C. Plummer.

DEFENDANT'S EXHIBIT 302

December 8, 1932

MEMORANDUM OF CONVERSATION WITH ROSS T. SANFORD

Subject:—Negotiations with Representatives of Pure Oil Company Leading up to First Treatment of Oil Well with Inhibited Acid.

Mr. Sanford recalls meeting Mr. Thomas of the Pure Oil Company in the Dow Main Office one day shortly after January 1, 1932, and taking him over to Mr. Grebe's office, at which time the subject of treating oil wells with acid, particularly inhibited acid, was first discussed. He is uncertain as to the presence of Mr. Humphrey at the time, but seems to recall that there was another Pure Oil man there.

As regards the ensuing conversation in Mr. Grebe's office, Sanford's recollection is vague, but it is his opinion that Pure Oil Company representatives had been experimenting with the use of acid to dissolve oil rock and had come here to consult with Dow Company men to get their recommendations as to the best procedure. He recalls that the Pure Oil representatives urged the possibility of a new market for HCl in well treating. Sanford does not recall clearly how the question of the use of inhibitors in the acid came up, but he does recall definitely that he recommended the use of chromate, which was the first material recommended during the conversation, and that Grebe later recommended arsenic as being better than chromate. He also recalls discussion as to the effect of the strength of the acid and that Grebe brought out a curve sheet showing that 15% HCl was about the best strength and that above that the amount of corrosion increased rapidly.

Sanford also recalls a later meeting with Humphrey in the field in which he sketched out this curve on the back

of an envelope and discussed the matter with Humphrey. Previously, the Pure Oil men had wanted to use full strength acid.

The treatment of the Fox Well No. 5 (or 6) was arranged when the Pure Oil representative, probably Mr. Humphrey, called up on February 10, 1932. Sanford called up Grebe to ask permission for Quinlan to take charge of the treatment of the well. He then called Quinlan to give the latter instructions for making up the acid, which Quinlan did. The next day, February 11, Sanford went out to the well along with Quinlan and the acid truck and was present when the first batch of acid was put into the well. He states that Quinlan measured the acid in the tank wagon and held the hose when the acid was run into the well. Sanford does not remember who were the representatives of the Pure Oil Company on the job at that time. On the day after the first treatment with acid, Sanford went back and got a sample of the spent acid which had been pumped out of the well and found that it was still slightly acid. He recalls that three later treatments were made using acid from the original tank wagon load, making four treatments in all from the 500 gallons of acid in the tank wagon. The treatments after the first were made by the Pure Oil Company's men. Previous to the treatment of the first well, Sanford recalls discussing with the Pure Oil Company men the effect of acid on oil-saturated Dundee rock and that they told him that acid had been tried and found to dissolve the rock, but were afraid that if acid was put into a well it would cause damage to it. He also recalls, about this time, talking with Mr. Griswold over the probable action of acid on oil-soaked rock in which Mr. Griswold doubted that the acid would attack the rock.

E. C. Burdick.

I have read the above memorandum and find it substantially correct according to the best of my knowledge and belief.

Ross T. Sanford.

January 5, 1933.

DEFENDANT'S EXHIBIT 303

December 8, 1932

MEMORANDUM OF CONVERSATION WITH JOHN J. GREBE

Subject:—Negotiations with Representatives of Pure Oil Company Leading up to First Treatment of Oil Well with Inhibited Acid.

The exact date of the first meeting between Messrs. Grebe and Sanford and Messrs. Thomas and Humphrey of the Pure Oil Company cannot be definitely established. It was, however, shortly after January 1, 1932. Grebe recalls the circumstances clearly. Mr. Sanford brought Messrs. Thomas and Humphrey into Mr. Grebe's office on that occasion. Grebe knew Thomas from several previous meetings, since Thomas, who was a geologist for the Pure Oil Company, had been in frequent contact with The Dow Chemical Company during the development of the local oil field, had consulted with regard to well drilling data and had had brine analyses run at the Main Laboratory. This was the first meeting with Humphrey, however, who was introduced to Grebe by Mr. Thomas.

Grebe states that Humphrey opened the conversation directly, stating that he had two problems to talk over which he thought the Dow Company might be of help in solving and in connection with which he wished to ask for recommendations as to the best way of attacking the problems. These problems were (1) treating oil wells with acid and (2) dissolving out paraffin with solvent.

Humphrey said that he had been trying to convince his superior, Mr. Carr, that acid would act upon oil-soaked rock, but that Carr refused to believe it. Humphrey had made some laboratory tests with samples of oil rock from the Dundee structure in which he had shown that hydrochloric acid would dissolve the rock.

Grebe told them that the Dow Company had used hydrochloric acid for treatment of brine wells and that he believed it would work for oil wells and could be made safe to use without damage to the well structure by adding an inhibitor to it. On the matter of inhibitors, Sanford made the first suggestion, stating that chromate would act and thereafter Grebe said that arsenic would be better and that it had been used on some of our own brine well treating jobs. Grebe states that he described in some detail to Thomas and Humphrey the work that we had done on brine wells in attempts to increase brine production and also for brine disposal through pumping back into old wells.

Grebe states that neither Humphrey nor Thomas showed familiarity with inhibited acids. Grebe explained to them how inhibitors worked. Grebe states that he remembers very clearly, after he had made this explanation, that Humphrey was much impressed and made the statement that, if inhibitors would work as Grebe stated, he (Humphrey) was sure that he could go back and convince Carr to let him treat a well with acid. Grebe is quite positive as regards this incident during the interview.

Following the interview of Grebe and Sanford with Humphrey and Thomas, it appears that the latter applied to their superiors for permission to treat a well with acid, but it was not until February 10, 1932, that they telephoned in that they had a well ready for treatment, this being the Fox No. 5 (or 6) well which was treated by the Dow Company on February 11, 1932.

Grebe recalls another conversation with Humphrey several months later, probably in May or June, 1932, in which some reference was made to the patent aspects of well treatment. Humphrey told him that the Pure Oil Company's Patent Attorney had made a search and found that the use of acid had been patented about forty years earlier and used in Ohio and California. Humphrey stated, in a general way, that his Company was well set on protection for methods of getting acid into the well. He then stated, further, to Grebe, as the latter clearly remembers,

that all the Dow Company had in connection with the treatment was the use of inhibitors. Grebe states that he reported this conversation to Mr. Griswold immediately afterward and urged that our patent application should be filed promptly.

E. C. Burdick.

I have read the above memorandum and find it substantially correct according to the best of my knowledge and belief.

John J. Grebe.

December 9, 1932.

DEFENDANT'S EXHIBIT 304

Pencil note—"Copy of this draft sent to Nelson at Wash. for use in connection with search. E. C. B."

TREATMENT OF DEEP WELLS

John J. Grebe
Disclosure No. 1173
Case No. 850-G
June 7, 1932

The present invention relates in general to the treatment of deep wells to increase the delivery of fluid mineral products therefrom and relates specifically to wells deriving such flow from an acid-soluble rock formation such as limestone, dolomite, magnesite, or other basic stratum, or

from any natural formation which may be dissolved wholly or in part by an acid, such as sandstone with a lime binder. It also relates to loosening scale and/or incrustations, such as salt scale, paraffin wax, etc., from the bore of the well by attack of an acid upon the rock to which such scale adheres.

After completion of a drilled hole into a mineral-bearing stratum for the purpose of obtaining oil, gas, water, brine, or other fluid mineral product, the flow thereof is not always as great as desired and "shooting" the well with nitroglycerine or other explosive is often resorted to in the hope of increasing the rate of flow. The explosion is thought to increase the flow area through which the fluid products may pass and enter the well, either by enlarging the bore thereof and/or by creating fissures in the surrounding rock. Such shooting of a well is a hazardous procedure, particularly when a heavy explosive charge is used, and serious damage may result, e.g., the rupture of the casing, the loss of the hole, together in some instances with tools later employed to clean it out. Other methods are accordingly desirable which will reduce such hazards and the present invention provides a method which has been proved successful in increasing the flow from wells of the character referred to.

To the accomplishment of the foregoing and related ends, the invention, then, consists of the steps hereinafter fully described and particularly pointed out in the claims, the following description setting forth in detail several modes of carrying out the invention, such disclosed modes illustrating, however, but several of various ways in which the principle of the invention may be used.

I will now describe my invention as applied to the treatment of an oil well in which the flow of oil is from a calcareous or limestone formation, or in which such a formation is adjacent to the stratum from which the oil is delivered to the bore of the well.

A quantity of an acid solution is introduced into the bottom of the well, which attacks or dissolves the mineral-

bearing rock formation at the base of the bore, accompanied by the evolution of carbon dioxide gas if, as is often the case, the rock is a calcareous formation. For the purpose, a strong mineral acid, such as hydrochloric acid, is best adapted. The acid solution is preferably of a strength such that the soluble salts formed by its action on the rock constituents will remain dissolved therein. The quantity of acid to be used in any case may vary greatly with the type and thickness of rock formation, size of bore, and other factors, but may be calculated as sufficient to fill the bore of the well to a height corresponding approximately to the thickness of the stratum to be acted upon. After the action of the acid has practically ceased, the spent solution containing the dissolved salts formed may be pumped or bailed out, after which the regular pumping of the well may be resumed. It has been found that the successful carrying out of the treatment greatly increases the output of the well.

If the well has not been previously shot with explosive, it may be advantageous to shoot same prior to applying the acid treatment. In such case, however, it will suffice to use a much smaller charge of explosive than otherwise customarily employed when the effect of the charge alone is to be depended upon to increase output. Such smaller charge may be used with greatly decreased hazard to the bore of the well or to casing or drive pipe.

Assuming, then, that the pump tubing and rods are in place, the rods may be withdrawn and the acid poured down the tube, followed by a quantity of oil to force the acid charge out of the bottom of the tube from which it will emerge into the bore and rise therein. A simple calculation based upon the known diameter of the hole and the known thickness and levels of the stratum of the rock to be attacked will enable the determination of a suitable volume for the charge of acid to be used, and the character of the rock and the solubility of the mineral salts resulting from the treatment will enable the determination of the strength of the acid such that the salts formed may be re-

tained in water solution and be removable with the water. After the evolution of carbon dioxide gas has substantially ceased, indicating that the acid has become exhausted, the pump rods may be relowered into the pump tube and the water solution of soluble salts pumped out. By continued pumping oil will be delivered as before, but usually at an increased rate. If the increase is not great enough at first, the treatment may be repeated, as already explained.

In order to prevent, or at least to minimize, the corrosive action of the acid on the pump tube or well casing it is advisable to add to the acid an inhibiting agent to reduce the rate of chemical action of the acid upon metallic surfaces in contact therewith. By so doing the well can be treated without removing the casing. As such agent I may select any of the known inhibitors which are used for acid pickling baths and the like. Examples of such inhibitors are arsenic compounds, cyanides, organic nitrogen bases such as pyridine, quinoline, acridine and derivatives thereof, as well as various by-products of industrial processes, such as sludge acid from oil refining and residues from acid sulphite paper manufacture, etc.

Alternative methods of procedure involve the application of additional pressure to the bore of the well after the charge of acid has been placed therein by admitting oil or water thereto, so as to increase the hydrostatic head on the acid, thereby forcing it into the pores or fissures of the rock and carrying its action deeper into the rock structure. A similar result may be attained in some cases if the hole is capped off after introducing the acid, so that the resulting increase in gas pressure due to liberation of carbon dioxide may be employed to increase the pressure upon the acid in the well and force it into the rock. Mechanical pressure may also be employed, as by use of a pump, to force acid into the rock by gas or liquid pressure.

Where working with a well in which the flow is from a siliceous rock not readily attackable by a mineral acid, but which stratum has a limestone or calcareous formation in juxtaposition thereto, acid treatment as herein described

may still be effective to improve the output of the well. The action of the acid on such juxtaposed stratum may result in opening up flow channels therethrough leading from the siliceous pay-rock stratum into the bore of the well. This procedure may be indicated for brine wells deriving their flow from a sandstone formation overlaid by, or in contact with, a calcareous stratum. If the pay-rock is siliceous and has a lime or magnesia binder, a similar procedure may dissolve out the binder and open up flow lines to the well.

In the practical use of my method in the central Michigan oil field where the oil is derived from a calcareous rock stratum, I have employed successfully commercial hydrochloric acid of 10° to 12° Be′ strength to which has been added a minor percentage of arsenic. The arsenic may be added as arsenic trioxide, As_2O_3, or arsenic acid, H_3AsO_4, or as any soluble arsenic compound, such as an alkali metal arsenite or arsenate. The amount added may be varied considerably, but from 1 to 5 per cent of the arsenic compound, based upon the weight of the solution, will usually be satisfactory for the purpose. Such procedure has permitted the introduction of the acid into the iron pump tube without involving consequential attack upon the iron. In a given instance, employing 4500 pounds of hydrochloric acid of 15 per cent strength, having a calculated content of 675 pounds HCl, 2 gallons of arsenic acid solution containing by calculation approximately 21 pounds As_2O_5 were used and good results obtained. It should be noted that when employing hydrochloric acid introduced through iron piping or by the use of iron equipment, the strength of the acid will advisedly be not over 15 per cent to 18 per cent HCl, since the rate of attack of hydrochloric acid upon iron, even with arsenic present, increases rapidly above 15 per cent strength, whereas below that strength, the rate of attack is low. As regards the action of the acid to attack and dissolve the rock formation, any strength of acid may be used which is effective for the purpose.

Hydrochloric acid will usually be preferred for use with my method, inasmuch as the calcium and magnesium salts, which are principally formed by the action of the acid on the rock, are readily soluble in water and are removed with the spent acid solution when the latter is withdrawn from the well. Nitric acid is also suitable from the standpoint of solubility of its salts, but the cost would be greater. Other mineral acids, such as sulphuric acid or phosphoric acid, may be used in some cases, but less desirably owing to the insolubility of the calcium salts of these acids.

The method described has been employed for the treatment of oil wells resulting in an increase of output amounting to as much as from 75 to 200 per cent, and in some cases wells which had ceased to flow have been brought back with a resumption of regular flow. The invention, however, may be applied equally well to increase the flow from gas wells, brine or deep water wells in cases where the mineral or water bearing stratum, or the immediately adjacent strata, are of a nature to be acted upon and dissolved by an acid solution.

1. In a method of increasing the output of a well for producing a fluid mineral product such as oil, gas, water or brine, the step which consists in introducing a mineral acid solution into the mineral bearing rock strata adjacent to the bore of the well.

2. In a method of increasing the output of a well for producing a fluid mineral product such as oil, gas, water or brine, the step which consists in introducing a hydrochloric acid solution into the mineral bearing rock strata adjacent to the bore of the well.

3. The method of increasing the output of a well for producing a fluid mineral product such as oil, gas or brine, which comprises introducing a mineral acid solution into the bore of such well, permitting the solution to act upon the rock formation in contact therewith and withdrawing the spent acid.

4. The method of increasing the output of a well for

producing a fluid mineral product such as oil, gas or brine, which comprises introducing a mineral acid solution into the bore of such well, permitting the solution to act upon the rock formation in contact therewith, while applying pressure upon the solution, and withdrawing the spent acid.

5. The method of increasing the output of a well for producing a fluid mineral product such as oil, gas or brine, which comprises pouring a mineral acid solution into the well casing, then closing the casing to prevent escape of gas, permitting the acid to act upon the rock formation at the base of the well under pressure due to the gas generated thereby and withdrawing the spent acid.

6. The method of increasing the output of a well for producing a fluid mineral product such as oil, gas or brine, which comprises introducing a hydrochloric acid solution into the bore of such well, permitting the solution to act upon the rock formation in contact therewith and withdrawing the spent acid.

7. The method of increasing the output of a well for producing a fluid mineral product such as oil, gas or brine, which comprises introducing a hydrochloric acid solution into the bore of such well, permitting the solution to act upon the rock formation in contact therewith, while applying pressure upon the solution, and withdrawing the spent acid.

8. The method of increasing the output of a well for producing a fluid mineral product such as oil, gas or brine, which comprises pouring a hydrochloric acid solution into the well casing, then closing the casing to prevent escape of gas, permitting the acid to act upon the rock formation at the base of the well under pressure due to the gas generated thereby and withdrawing the spent acid.

9. The method of increasing the output of a well for producing a fluid mineral product such as oil, gas or brine, which comprises pouring a hydrochloric acid solution containing a corrosion inhibitor into the metallic well casing, or tubing, then closing the casing to prevent escape of gas, permitting the acid to act upon the rock formation at the

base of the well under pressure due to the gas generated thereby and withdrawing the spent acid.

10. The method of increasing the output of a well for producing a fluid mineral product such as oil, gas or brine, which comprises pouring a hydrochloric acid solution containing a relatively small amount of an arsenic compound into the metallic well casing, then closing the casing to prevent escape of gas, permitting the acid to act upon the rock formation at the base of the well under pressure due to the gas generated thereby and withdrawing the spent acid.

11. The method of increasing the flow of oil in an oil well to which the oil flows through or in proximity to a stratum of calcareous rock which comprises introducing a mineral acid solution into the bore of such well, wherein such acid acts upon the calcareous rock to disintegrate and dissolve the same.

12. The method of increasing the flow of oil in an oil well to which the oil flows through or in proximity to a stratum of calcareous rock which comprises introducing a hydrochloric acid solution into the bore of such well, wherein such acid acts upon the calcareous rock to disintegrate and dissolve the same.

13. The method of increasing the flow of oil in an oil well to which the oil flows through or in proximity to a stratum of calcareous rock which comprises introducing hydrochloric acid containing a corrosion inhibitor into the bore of such well, wherein such acid acts upon the calcareous rock to disintegrate and dissolve the same.

14. The method of increasing the flow of oil in an oil well to which the oil flows through or in proximity to a stratum of calcareous rock which comprises introducing a 10 to 15 per cent hydrochloric acid solution containing a relatively small amount of an arsenic compound into the bore of such well, wherein such acid acts upon the calcareous rock to disintegrate and dissolve the same.

DEFENDANT'S EXHIBIT 312

DEPARTMENT OF COMMERCE
United States Patent Office

To all persons to whom these presents shall come, Greeting:

This Is To Certify that the annexed is a true copy from the records of this office of the File Wrapper and Contents, in the matter of the

Letters Patent of
John J. Grebe and
Ross T. Sanford, assignors to

The Dow Chemical Company,
Number 1,877,504, Granted September 13, 1932,
for
Improvement in Treatment of Deep Wells.

In Testimony Whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed, at the City of Washington, this fifth day of July, in the year of our Lord one thousand nine hundred and thirty-nine and of the Independence of the United States of America the one hundred and sixty-fourth.

(Seal) Conway P. Coe,
Commissioner of Patents.

Attest:
D. E. Wilson,
Chief of Division.

PATENT No. 1877504
1932

Number (Series of 1925) 620292 Dated Sep 13 1932
Div. 38 (Ex'r's Book).....
Name John J. Grebe and Ross T. Sanford, Assors to The Dow Chemical Company of Midland, Mich, a corp of Michigan.
Invention Treatment of Deep Wells

Defendant's Exhibit 312

ORIGINAL

Application Filed Complete June 30, 1932
Petition, Specification, Oath, First Fee $25, June 30, 1932
Examined and passed for Issue August 17, 1932
C. F. Krafft, Exr. Div. 38
Notice of Allowance Aug. 17, 1932
By Commissioner.
Final Fee $30—Aug. 17, 1932
Attorney, Thomas Griswold, Jr., c/o The Dow Chemical Co—Midland, Mich.
No. of Claims Allowed 11. Print Claim 1 in O. G.
Class 166-21
Title as Allowed—Treatment of Deep Wells

THOMAS GRISWOLD, JR.
Patent Research Dept.
The Dow Chemical Company
Midland, Michigan

Midland, Michigan, June 24, 1932
Inventors J. J. Grebe and R. T. Sanford
Title Treatment of Deep Wells
Commissioner of Patents,
Washington, D. C.
Sir:—

In connection with the above entitled case, please apply the enclosed remittance in payment of Patent Office fees in the amounts and for the purpose below indicated:
Patent Design Trade-Mark Application Filing Fee Twenty-five Dollars ($25.00)

Respectfully,
Thomas Griswold, Jr.,
Attorney.

Defendant's Exhibit 312

PETITION AND POWER OF ATTORNEY

To the Commissioner of Patents:— 620292

Your petitioners, John J. Grebe and Ross T. Sanford, citizens of the United States, and residents of Midland, County of Midland, State of Michigan, and whose Post Office address is Midland, Michigan, pray that Letters Patent may be granted to them as joint inventors for the Improvements in Treatment of Deep Wells set forth in the annexed specification; and they hereby appoint Mr. Thomas Griswold, Jr., of Midland, Michigan (care of The Dow Chemical Company) (registration No. 12803) their attorney in this application, with full power in the premises.

John J Grebe
Ross T. Sanford

SPECIFICATION

To All Whom It May Concern:—

Be It Known that we, John J. Grebe and Ross T. Sanford, citizens of the United States, and residents of Midland, County of Midland, State of Michigan, have jointly invented a new and useful Improvement in Treatment of Deep Wells of which the following is a specification:

The present invention relates to the treatment of deep wells, such as oil, gas, brine or water wells, to increase the output therefrom. It is more especially concerned with the treatment of wells in which the mineral-bearing stratum consists of a limestone or other calcareous formation, or is contiguous to such a formation.

An object of the invention is to counteract some preventable natural causes for the decline of yield of a well. A familiar example is the decline of production of an oil well. When it is first drilled into an oil-bearing stratum, the release of pressure upon the oil deposit may cause the well to flow naturally for a certain length of time. The flow will gradually recede from the initial high point to the point where natural

flow does not produce a sufficient yield, and thereafter pumping will be resorted to, until the continued decline in output renders further operation unprofitable. In many cases, however, the stoppage of oil output is caused, not by exhaustion of the oil supply, but by the building up of solid deposits *of wax or the like* in the channels and pores of the oil-bearing rock which obstruct and finally may cut off altogether the flow of oil to the well.

Various methods have been used for opening up or cleaning a clogged well hole, such as drilling, "shooting," with explosive or by chemical treatment. The first two methods mentioned have the disadvantage that the pump rod and tube must be removed prior to applying the treatment, in addition to which, in the case of using an explosive, there is danger of damaging the casing. The chemical methods heretofore proposed have either not been found effective to clear the hole or they have involved the use of corrosive substances which are injurious to the metal parts of the well structure.

As an illustration, a chemical method is described in United States Patent 556,669, according to which the flow of an oil well in a limestone formation is increased by treating with a quantity of an acid, such as hydrochloric acid. The acid has the effect of attacking and dissolving the rock, thereby enlarging the cavity at the bottom of the well, or the channels and pores in the rock through which oil flows to the well. In actual practice, however, this method has never been generally adopted, due to the fact that the acid attacks the metallic casing, pump tube, etc., about as actively as the rock, and causes serious damage thereto.

We have now found that the last-mentioned method may be adapted for use in increasing or restoring the flow of oil wells by suitable modification without material injury to the casing or other metallic parts of the well. The treatment can be carried out at less cost and with better results than any of the methods heretofore employed. The invention, then, consists of the improved method hereinafter fully described and particularly pointed out in the claims.

In carrying out our improved method we employ a mineral

acid, preferably hydrochloric acid, inasmuch as the latter upon reacting with the calcareous rock forms water-soluble salts which remain in solution and are removed from the well with the spent acid. To the acid we add a small amount of a substance capable *, e.g. of iron or steel, copper, etc.,* of inhibiting attack of the acid upon metal surfaces with which it comes in contact. As the inhibiting agent we prefer to use an arsenic compound soluble in the acid solution, examples of which are arsenic acid, H_3AsO_4, arsenic trioxide, As_2O_3, or a soluble arsenate or arsenite, such as the corresponding alkali metal salts. The amount of arsenic compound added may be varied, but we have found that from 1 to 5 per cent thereof, based upon the weight of the solution, will be satisfactory for the purpose. Other inhibitors which may be used are cyanides, organic nitrogen bases such as aniline, phenyl-hydrazine, pyridine, quinoline, acridine and derivatives thereof, organic sulphur compounds, such as mercaptans, as well as various by-products of industrial processes, such as sludge acid from oil refining and residues from acid sulphite paper manufacture, etc.

The strength of the aqueous hydrochloric acid solution, in *best adapted to the purpose in hand* general, may be between about 5 per cent and about 20 per cent, *although other concentrations may be used, if desired* and preferably should be between 10 and 15 per cent. With such strength of acid the corrosive action thereof upon metals, particularly iron or steel, can be largely or substantially inhibited by adding thereto a relatively small amount of an arsenic compound or other inhibiting agent. Consequently, the acid can be introduced into the well through the pump tube, so that the latter need not be withdrawn prior to the treatment. It is sufficient merely to pull the pump rod and valves, and to pour the acid solution into the well through the tube. Due to the presence of the inhibitor there will be no substantial attack upon the pump tube, or upon the well casing if the charge of acid rises high enough in the well to contact with the casing.

The acid solution is preferably added in amount calculated to fill the bore of the well to a depth not exceeding the thickness of the mineral-bearing stratum. In order to force

the charge of acid out of the pump tube into the bore of the well against the head of oil standing in the hole, it may be followed by a charge of oil, water or other liquid sufficient to overcome the head, or pressure may be applied by other suitable means, e.g. by air pressure or by means of a pump. When introduced into the bottom of the well, the acid attacks the rock structure and dissolves or disintegrates it, thereby enlarging the pores and channels in the rock, or opening up new channels. The action of the acid upon a limestone formation causes the evolution of a considerable volume of carbon dioxide gas. This gas may be allowed to escape up the casing, or the latter may be capped off, thereby creating a gas pressure within the well which assists in forcing the acid into the pores and crevices of the rock. After the action of the acid has practically ceased, the spent solution containing the dissolved salts may be pumped or bailed out. In many cases it may be desirable to repeat the treatment one or more times. By making successive additions of smaller amounts of acid solution, and pumping out the spent acid between charges, a greater cumulative effect may be produced than by the use of a single larger charge. It is not necessary, however, to add the acid solution through the pump tube, as any other convenient way may be employed. For instance, the pump tube may be withdrawn and a dump bailer used to lower a charge of acid into the base of the bore.

In the practical use of our method in the central Michigan oil field, where the oil is derived from a calcareous rock formation, we have successfully used hydrochloric acid solutions of 10 to 15 per cent strength to which was added a small amount e.g. 1 to 5 per cent, of an arsenic compound. For example, to 4500 pounds of a 15 per cent hydrochloric acid solution was added 2 gallons of arsenic acid solution containing 21 pounds of arsenic calculated as As_2O_5. The mixed solution was charged into an oil well through the iron pump tube, being followed by a quantity of crude oil to force the acid solution out of the tube into the well. After the acid was exhausted, it was pumped out, and thereupon regular pumping of the oil was resumed. The production of the well was approximately doubled with one treatment.

The method has been used repeatedly for the treatment of low yield or exhausted oil wells in producing territory with a resultant increase of output amounting to as much as 75 to 200 per cent, and in some cases wells which have ceased to flow have been brought back with a resumption of natural flow. The treatment has been applied in the manner described without appreciable damage to the pump tube or well casing. The invention may also be employed similarly to increase the flow of gas wells and brine or water wells in cases where the mineral or water-bearing stratum, or the immediately adjacent strata, are of a limestone or calcareous formation, or of a nature such as to be acted upon and dissolved by hydrochloric acid solution.

Other modes of applying the principle of our invention may be employed instead of the one explained, change being made as regards the method herein disclosed, provided the step or steps stated by any of the following claims or the equivalent of such stated step or steps be employed.

We therefore particularly point out and distinctly claim as our invention:—

—1—

In a method of increasing the output of a well for producing a fluid mineral product such as oil, gas, water or brine, the step which consists in introducing into the well an aqueous hydrochloric acid solution to which has been *an agent capable of inhibiting action of the acid upon metals.* added a relatively small amount of ~~a corrosion inhibiting agent.~~

—2—

In a method of increasing the output of a well for producing a fluid mineral product such as oil, gas, water or brine, the step which consists in introducing into the well an aqueous hyrochloric acid solution to which has been *capable of inhibiting action of the acid upon metals* added a relatively small amount of an arsenic compound.

—3—

In a method of increasing the output of a well for producing a fluid mineral product such as oil, gas, water or

brine, the step which consists in introducing into the well a 5 to 20 per cent hydrochloric acid solution to which has *capable of inhibiting action of the acid upon metals* been added from 1 to 5 per cent of an arsenic compound.

—4—

In a method of increasing the output of a well for producing a fluid mineral product such as oil, gas, water or brine, the step which consists in introducing into the well a 5 to 20 per cent hydrochloric acid solution to which has been added from 1 to 5 per cent of arsenic acid.

—5—

The method for increasing the output of an oil well *base* which comprises introducing into the ~~bore~~ of such well a 5 to 20 per cent hydrochloric acid solution containing a relatively small amount of a corrosion inhibitor, permitting the acid to act upon the rock formation surrounding the well cavity and withdrawing the spent acid.

—6—

The method for increasing the output of an oil well *base* which comprises introducing into the ~~bore~~ of such well a 5 to 20 per cent hydrochloric acid solution containing a rela- *capable of inhibiting action of the acid upon metals* tively small amount of an arsenic compound, permitting the acid to act upon the rock formation surrounding the well cavity and withdrawing the spent acid.

—7—

The method for increasing the output of an oil well *base* which comprises introducing into the ~~bore~~ of such well a 5 to 20 per cent hydrochloric acid solution containing a relatively small amount of a corrosion inhibitor, permitting the acid to act upon the rock formation surrounding the well cavity while applying pressure upon the solution and withdrawing the spent acid.

—8—

The method for increasing the output of an oil well *charging* which comprises ∧ ~~pouring~~ into the pump tube a quantity of a 5 to 20 per cent hydrochloric acid solution containing a relatively small amount of a corrosion inhibitor, expelling the acid from the tube into the bore of the well by applying pressure thereon, permitting the acid to act upon the rock formation surrounding the well cavity and withdrawing the spent acid.

—9—

The method for increasing the output of an oil well *charging* which comprises ∧ ~~pouring~~ into the pump tube a quantity of a 5 to 20 per cent hydrochloric acid solution containing a relatively small amount of a corrosion inhibitor, expelling the acid from the tube into the bore of the well by applying pressure thereon, permitting the acid to act upon the rock formation surrounding the well cavity under pressure due to the gas generated thereby and withdrawing the spent acid.

Signed by us this 24 day of June, 1932.

John J. Grebe
Ross T. Sanford

OATH

State of Michigan, County of Midland, ss.

John J. Grebe and Ross T. Sanford, being duly sworn, depose and say that they are the applicants herein, citizens of the United States, and residents of Midland, Michigan; that they do verily believe themselves to be the original, first and joint inventors of the Improvement in Treatment of Deep Wells described and claimed in the foregoing specification, signed by them; that they do not know and do not believe that the same was ever known or used before their invention or discovery thereof, or patented or described in any printed publication in this or any foreign

country before their invention or discovery thereof, or more than two years prior to this application, or in public use or on sale in this country for more than two years prior to this application; that their invention has not been patented to themselves or others with their knowledge or consent in any foreign country on an application filed by them, or their legal representatives or assigns, more than twelve months prior to this application and that no application for patent on same has been filed by them, or their legal representatives or assigns, in any foreign country, except as follows: —None.

John J. Grebe
Ross T. Sanford

Sworn to and subscribed before me, this 24 day of June, 1932.

(Seal) Geneva Turner,
Notary Public.

My commission expires July 7, 1934.

Midland, Michigan, July 30, 1932

Hon. Commissioner of Patents
Sir:

Prior to examination, I hereby amend as follows:

√Page 2, line 18, after "deposits" insert—of wax or the like—.

√Page 3, line 25, after "surfaces" insert—, e.g. of iron or steel, copper, etc.,—.

Page 4, line 10, after "general" insert—best adapted to the purpose in hand—; √line 11, change the period (.) to a comma (,) and add—although other concentrations may be used, if desired—.

√Claim 1, last line, cancel "a corrosion inhibiting agent" and substitute therefor—an agent capable of inhibiting action of the acid upon metals—.

√Claims 5-7, line 2 of each, change "bore" to—base—.

√Claims 8-9, line 2 of each, change "pouring" to—charging—.

Please add the following claims:—

10. In a method of treating a well for producing a

fluid mineral product such as oil, gas, water or brine, the step which consists in introducing into the well an aqueous hydrochloric acid solution to which has been added a relatively small amount of an organic nitrogen base capable of inhibiting action of the acid upon metals.

11. In a method of treating a well for producing a fluid mineral product such as oil, gas, water or brine, the step which consists in introducing into the well an aqueous hydrochloric acid solution to which has been added a relatively small amount of an organic sulphur compound capable of inhibiting action of the acid upon metals.

REMARKS

The foregoing amendment to the specification is for the purpose of correcting and clarifying the text in certain details. The new claims added are of similar scope to claim 2, but read to two additional species. Claim 1 is to be regarded as the generic claim and claims 2, 10, and 11 read to three selected species, in accordance with Rule 41.

Respectfully

Thomas Griswold, Jr.,

ECB:GT Attorney.

PETITION TO MAKE SPECIAL

Hon. Commissioner of Patents

Sir:

Your Petitioner, The Dow Chemical Company, assignee of the entire right, title and interest in and to the patent application of John J. Grebe and Ross T. Sanford, Serial No. 620,292, filed June 30, 1932, for "Treatment of Deep Wells," by its attorney, for the reasons enumerated below and set forth in the accompanying affidavits, prays that the aforesaid application, Serial No. 620,292, be made special in order to expedite its early issuance into a patent.

The Dow Chemical Company is actively engaged in the manufacture and sale of specially prepared acid for treating oil wells in accordance with the method described in the

aforesaid application, and is also contracting with oil well operators for treating wells. The feature of the method consists in the use of a prepared acid which does not attack and corrode metallic pipes, valves, pumps, and other parts of well equipment. The first test of the method was made March 11, 1932. The success of the first and subsequent trial treatments of wells has led to the general adoption of the method for treating oil wells in the Central Michigan field, and such use is being extended to other fields. The rapid adoption of the method has attracted general attention in the oil producing industry, and competitors have entered the field who are making unauthorized and unlicensed use of the invention which is causing loss to Petitioner's business. It is submitted that a continuation of such infringement will cause unlimited and irreparable damage.

Wherefore your Petitioner begs that a favorable consideration be given to this petition, and that the application of John J. Grebe and Ross T. Sanford, Serial No. 620,292, be advanced for special action.

The Dow Chemical Company
By Thomas Griswold, Jr.,
Attorney.

AFFIDAVIT IN SUPPORT OF PETITION TO MAKE SPECIAL

State of Michigan, County of Midland, ss.

Your affiant, Russell L. Curtis, being duly sworn, deposes and says that he is Assistant Sales Manager of The Dow Chemical Company, assignee of the above identified application, and that he is familiar with the said application.

Affiant further avers that The Dow Chemical Company is actively engaged in the manufacture and sale of specially prepared hydrochloric acid for treating oil wells in accordance with the method described in the aforesaid application, including the contracting with oil well operators for

treating their wells. Although this business has been developed within the past six months, it already amounts to a considerable volume. Since June 1, 1932, approximately 55,000 gallons of prepared acid have been sold, sufficient at average rate of application for the treatment of over one hundred wells, and that twenty-eight wells have been treated on contract by The Dow Chemical Company.

Affiant further avers that the new method of treating oil wells has attracted widespread attention in the industry, that unlicensed use of the invention claimed in the aforesaid application is being made by competitors, and that such unlicensed use is being made openly in defiance with the rights of The Dow Chemical Company as assignee of the aforesaid application, particularly by the firm of Dougherty and McMillan of Mt. Pleasant, Michigan.

Affiant further avers that the business of treating oil wells and the like according to the invention has developed with great rapidity, that the knowledge of the method has spread throughout the industry, and that within the next few months the continuation of unlicensed use of the invention will seriously affect the sales of the acid product and of the service of The Dow Chemical Company and that irreparable damage will be done to its business unless reasonable patent protection can be granted promptly rather than having to wait upon the usual long delay in the Patent Office resulting from the arrearage in the examining division having charge of this application.

Russell L. Curtis.

Sworn to and subscribed before me this 1 day of August, 1932.

Fred H. Brown,
Notary Public.

(Seal)

My Commission expires Apr. 19, 1933.

AFFIDAVIT IN SUPPORT OF PETITION TO MAKE SPECIAL

State of Michigan, County of Midland, ss.

I, Thomas Griswold, Jr., the undersigned, being duly sworn, depose and say that I am Patent Attorney for The Dow Chemical Company and am in charge of the Patent Department of said Company; that I am fully authorized and do hereby promise to follow closely the prosecution of the above identified application, Serial No. 620,292, and to cooperate in every way with the Examiner to expedite the issuance of the patent.

Thomas Griswold, Jr.

Sworn to and subscribed before me this 1st day of August, 1932.

Geneva Turner,
(Seal) Notary Public.

My commission expires July 7, 1934.

ASSOCIATE POWER OF ATTORNEY

Hon. Commissioner of Patents
Washington, D. C.
Sir:

You are hereby authorized and requested to recognize Messrs. Fay, Oberlin and Fay, a firm composed of Jesse B. Fay, John F. Oberlin and Horace B. Fay, 909 Leader Building, Cleveland, Ohio, (registration No. 3987), as my associate attorney in the above entitled application.

Respectfully
Thomas Griswold, Jr.,
August 1, 1932 Attorney of Record.

AFFIDAVIT

Your affiant, Almon S. Nelson, a registered patent attorney associated with Fay, Oberlin & Fay, states that he is familiar with the application of J. J. Grebe and R. T.

Sanford noted above and that he thoroughly understands the invention described and claimed therein:

Affiant avers that he has made a complete and comprehensive investigation through the appropriate classes of patents in the United States Patent Office involving treatment of wells and that as a result of such search, believes the invention set forth in said application to be a novel improvement over the prior art.

Affiant states that he has failed to find any patent or patents, disclosing the features of this application, i.e. the steps of the process recited in the claims.

Affiant further avers that he has carefully considered the claims in this application in view of the disclosures in the prior art and that he believes such claims to be patentable.

Almon S. Nelson.

Sworn to and subscribed before me, this 3rd day of August, 1932.

Anna A. Hammond,
(Seal) Notary Public, D. C.

Commission will expire 7/14/33.

AFFIDAVIT IN SUPPORT OF PETITION TO MAKE SPECIAL

State of Michigan, County of Midland, ss.

Your affiant, Thomas Griswold, Jr., being duly sworn, deposes and says that he is Patent Attorney for The Dow Chemical Company, assignee of the above identified application, that he is in charge of the prosecution of said application and that he is familiar with the specification and claims thereof. Affiant affirms that a salesman of The Dow Chemical Company has described to him the method of treating oil wells which has been employed by the firm of Dougherty and McMillan of Mt. Pleasant, Michigan, and that such method has been employed to treat at least four wells. Affiant further affirms that he has made a rigid com-

parison of the method practiced by the aforementioned firm and that it infringes at least some of the claims of the application, particularly claim 1 thereof. Affiant further affirms that he believes claim 1 and other claims in the application to be truly patentable.

Thomas Griswold, Jr.

Sworn to and subscribed before me this 3 day of August, 1932.

(Seal) Geneva Turner,
Notary Public.

My commission expires July 7, 1934.

PETITION TO MAKE CASE "SPECIAL"

The petition to make this case special has been considered.

If the examiner can make this case special without prejudice to any possible interfering applications, and he should make a rigid search for such, he is authorized to do so for the first action. Should the application be rejected, the case will not be considered special for the subsequent action unless the applicant *promptly* makes a *bona fide* effort to place the case in condition for allowance even if it is necessary to have an interview with the examiner to accomplish this purpose.

If the examiner finds any interfering application for the same subject matter, he should consider such application simultaneously with this case and should state in the official letter of such application that he is taking it out of its turn because of a possible interference.

The petition is granted.

Thomas E. Robertson,
Commissioner.

cfk) kh/d (Mailed Aug 8 1932)

DEPARTMENT OF COMMERCE
United States Patent Office
Washington

Please find below a communication from the Examiner in charge of this application.

Thomas Griswold, Jr;
c/o The Dow Chemical Company
Midland, Michigan

References made of record:

Muehl	1,410,827	Mar. 28, 1922	166/21
Lake et al.	1,498,045	June 17, 1924	"
Tilton	1,608,869	Nov. 30, 1926	"
Ranney et al.	1,806,499	May 19, 1931	"
Coggeshall	1,822,271	Sept. 8, 1931	"
De Groote	1,823,439	Sept. 15, 1931	"
" "	1,823,440	" 15, 1931	"

Bulletin 233 of the U. S. Bureau of Mines, (1925), pp. 82-85.

Petroleum Development and Technology in 1926, (book) published by American Institute of Mining and Met. Eng., Inc., p. 479, lines 9-11.

Claims 1, 5, 7, 8, and 9 are rejected on Ranney et al who carries out all steps of the process except that he makes no mention of using inhibitors. However, the use of chromates and mud-fluids as inhibitors is suggested in the book on Petroleum Development and Technology, and also in Bulletin 233 of the Bureau of Mines. The use of mud as an inhibitor is also suggested by Lake et al. Furthermore any dissolved chloride would operate as an inhibitor by suppressing the dissociation of the hydrochloric acid, and such chlorides would inevitably be present.

In view of the foregoing considerations it is not thought possible to draw any allowable claim which is not limited to some specific kind of inhibitor, and in the absence of any allowable generic claim, an election will have

to be made between the use of arsenic, nitrogen, and sulphur compounds as inhibitors. Division is therefore required between claims 2, 3, 4, and 6, claim 10, and claim 11.

C. F. Krafft,
Examiner.

(Application Div. Aug 13-32 U. S. Patent Office) (U. S. Patent Office Aug 13 1932 Division 38)

Washington, D. C., August 12, 1932.

Hon. Commissioner of Patents,
Sir:

In re application of Grebe et al., "Treatment of Deep Wells, filed June 30, 1933, Serial No. 620,292.

Attention is respectfully called to an interview had of the even date herewith, at which time the Primary Examiner agreed to reconsider applicant's claims in the light of the following argument which agreement is understood to waive the requirement for division at present.

The rejection of claims 1, 5, 7, 8, and 9 on Ranney et al is not understood. Ranney introduces a mixture of hydrochloric acid or nitric acid with a compound capable of reacting therewith to produce both heat and a gas (e.g. calcium carbide or other metal carbide) into an oil well. The well is then plugged and the gas formed by reaction of the carbide with the acid forces the latter into the oil-bearing rock structure. Ranney does not employ any agent capable of inhibiting the action of the acid upon metal surfaces within the well. To the contrary, he points out on page 1, lines 34 and 35 of his application that before treating the well according to his method "Any tubing or other equipment in the well casing is removed - - -."

The present invention comprises increasing the output of a well by introducing thereto a mixture of aqueous hydrochloric acid and a relatively small amount of an agent capable of inhibiting action of the acid upon metal equipment which may be present in the well. It is old, as is pointed out on page 3, lines 1-11 of the present application,

to treat an oil well with hydrochloric acid alone so as to increase the output thereof, but this method has never been generally adopted due to the fact that the acid attacks the metal casing of the well, pump tube, etc., and causes serious damage thereto. The impracticality of employing a strong mineral acid alone for oil well treatment is particularly pointed out on page 73 of the United States Bureau of Mines Bulletin No. 348, wherein it is stated

> "The use of strong acids such as hydrochloric and sulphuric as solvents for paraffin in oil wells is not recommended because paraffin is a relatively stable compound and will not be affected by such compounds. Furthermore, *acid may attack and do considerable damage to the equipment in the well - - -.*"

The utility of hydrochloric acid treatment in increasing the flow of an oil well was first pointed out by Frasch in United States Patent 556,669 in 1896, but this method has never found general application due to the danger of corroding metal apparatus within the well. Present applicants have found and are first to find that any of a wide variety of inhibiting agents may be added to hydrochloric acid to prevent its attack upon metal surfaces within a well and that the so-treated acid may be employed to increase the flow of a well without danger of corroding metal surfaces within the same. Since hydrochloric acid which contains a corrosion inhibiting agent does not attack iron, the acid, as pointed out on page 4, lines 15-17 of the specification,

> "can be introduced into the well through the pump tube so that the latter need not be withdrawn prior to the treatment."

Applicants' method, which is now being used extensively in certain oil fields, is advantageous over that described by Ranney in that applicants treat a well with aqueous hydrochloric acid which contains an agent capable of inhibiting the action of the acid upon metals within the well. Claims 1, 5, 7, 8, and 9, which were rejected on Ranney, distinguish from the latter in specifying that the

hydrochloric acid with which a well is treated shall contain such inhibiting agent.

In the last Office action it is stated

> "The use of chromates and mud-fluids as inhibitors is suggested in the book on 'Petroleum Development and Technology' and also in Bulletin No. 233 of the Bureau of Mines."

This statement is thought to be incorrect. In lines 9-13 of page 497 of "Petroleum Development and Technology" it is stated

> "In fact we find that both the depth of pitting and the total amount of corrosion *may be limited by the use of sufficient chromate. If an insufficient amount is used* to inhibit corrosion the *result would probably be* a slowing down of average rate of corrosion by an *acceleration of local corrosion in the form of pitting.*"

From the photostatic copy which is available of the above reference it is not clear what type of corrosion is referred to or to what purpose the corrosion inhibitor is to be applied. However, the reference shows clearly that a chromate cannot be applied successfully to prevent corrosion within a well, as it is perfectly evident that during pumping of the well the amount of chromate present would be reduced, but that a small amount of chromate would undoubtedly remain within the well and such small amount of chromate would increase the pitting of iron by corrosive agents. The above reference does not refer to the use of mud as a corrosion inhibitor.

Bulletin 233 of the United States Bureau of Mines gives a full discussion both of the use of chromates in preventing corrosion of iron apparatus within a well and of the use of mud for similar purpose. *The chromate treatment* is described on pages 84 and 85 of said reference and *consists in emmersing the iron or steel in solutions of inhibitive agents such as solutions of chromic acid and of certain chromate and bichromate salts.* Obviously, *such*

treatment of iron apparatus *must be carried out before the apparatus is placed within a well, hence the inhibiting agent*, a chromate, *is not employed along with an acid which is to be introduced* into the well. Furthermore, the reference specifically points out that such chromate treatment, when applied to iron apparatus which is to be used within a well, is useless as such corrosion inhibitor does not afford protection against chlorides or sulphates which may be present within the well, viz.:

> *"The protection afforded underground equipment by chromate solutions is of doubtful value* not only because the passive surface of the metals becomes scratched and worn away but *mainly because the passivity* is temporary at best and *is destroyed by chlorides* and sulphates *if present even in very small proportions in underground waters. A few hundredths of 1 per cent of a chloride* or a somewhat greater proportion of sulphate *appears to destroy the passivity afforded by chromate solutions. Chromate solutions may have special uses as inhibitors of the corrosion of surface equipment in the oil and gas fields, but for underground use in wells these reagents are believed to be useless."*

The above quotation shows clearly that a chromate will not prevent corrosion of iron or steel by a chloride and this fact is particularly true if hydrochloric acid, which is known to be highly corrosive to iron and steel, is the chloride referred to. *A chromate, then, can not be used in small proportion along with hydrochloric acid to prevent said acid from attacking iron equipment within a well, hence a chromate cannot be used as an inhibiting agent in the manner described in the present application.* The reference does not describe treating a well with hydrochloric acid containing a corrosion inhibitor nor does it show there to be any advantage in treating a well with such mixture. The reference, then, does not anticipate the present invention.

Pages 73-82 of Bulletin 233 of the Bureau of Mines, describe the use of mud-fluids, oil muds, and cements to pre-

vent corrosion of well casings by corrosive fluids such as the brines which may be present in the various strata through which said casing may pass. The general method of applying such protective agents is outlined in detail on page 74 of the reference and consists essentially in forming a layer of the protective mud around the iron or steel casing of the well and between such casing and the various earth strata through which the casing passes. From the entire description of such mud treatment in the above article it is entirely clear that *the mud-layer does not play the part of a corrosion inhibitor*, but *rather it serves as a wall between the iron or steel casing of the well and corrosive liquids, such as brines, which may be present within the earth's surface. The reference does not disclose treating an oil well with a mixture of hydrochloric acid and mud, nor does it show that mud will inhibit the action of hydrochloric acid upon iron equipment within the well.* The reference, then, discloses no essential feature of the present invention and cannot be held to anticipate the latter.

Lake et al describe removing colloidal muds, clays, etc., from the walls of a well hole or from apparatus within said hole by introducing into the well that amount of a strong mineral acid which is required to destroy the colloidal properties of the muds, clays, etc. On page 1, lines 100 to 109 of his patent Lake states

> "*It is found that the acid or acids* used for these purposes *will not appreciably attack the metallic structures in the well hole*, such as tubing and casing, collars, and the like, where mud is present in the hole, *unless used to excess*, inasmuch as *when an approximate balance between the amount of acid and colloidal mud is maintained the acid action will be expended upon the mud rather than in attacking the metal.*"

Lake does not disclose the use of mud as an agent capable of inhibiting the action of excess acid on iron equipment within a well. To the contrary, he specifically has pointed out in the above quotation *that the protective action of the*

mud is due to it reacting with the acid more quickly than will iron or steel and he also has particularly pointed out that the acid must be employed in amount which shall not exceed that with which the mud will react, i.e. there must be a balance between the mud and the acid. Present applicants have shown that a relatively small amount of any of a wide variety of inhibiting agents may be added to hydrochloric acid and that thereafter said acid may be introduced into a well to increase the flow thereof without injury to any metal apparatus which may be within the well. In employing an inhibiting agent for such purpose, the acid is in great excess over the quantity of inhibiting agent present. In so far as is known, there is no chemical action between the corrosion inhibitor and the acid, and the acid is present in free form so that all of its activity may be expended upon the oil containing calcareous rock structure rather than upon iron apparatus present within the well. Lake does not show that mud may be introduced into an excess of hydrochloric acid and that the so-treated acid may be introduced into an oil well without injury to metal apparatus which may be within said well, and it is not thought that mud can be employed for such purpose. Lake does not disclose any inhibiting agent capable of preventing the action of *excess hydrochloric acid* upon the metal apparatus which may be present within a well treated with said acid, nor does he disclose adding any inhibiting agent to hydrochloric acid and subsequently treating a well with the acid. Lake, then, discloses no essential feature of the present invention and does not anticipate the same.

Muehl describes a method of cleaning oil wells which consists essentially, first, in dissolving solid or gummy paraffin hydrocarbons within the well with oil capable of dissolving the same, removing the resulting solution, then introducing acid into the well by means of a combination of a scraper and an acid container having zinc plates as a temporary bottom of the same, said container being filled with a strong mineral acid, such as hydrochloric acid. The well is scraped at the bottom thereof and at the same time

the acid gradually eats through the zinc plates and is introduced directly into contact with the oil bearing rock structure at the bottom of the rock. Muehl does not disclose the use of any agent capable of inhibiting the action of the acid upon metal apparatus which may be present within the well and the Examiner's attention is particularly directed to the fact that the acid employed by Muehl must be highly corrosive towards metals because the operation of Muehl's entire process is dependent upon the acid eating its way through the metal bottom of the container within which it is introduced into a well. Muehl does not disclose the essential feature of the present invention, hence cannot be held to have anticipated the latter.

Tilton describes a different method of cleaning an oil well. The principal steps of his method consist, first, in introducing water into the bottom of the well, next, lowering a container filled with sulphuric acid into the well and liberating said acid into direct contact within the water which was first introduced, thereby generating sufficient heat to melt a considerable portion of the solid paraffins which are present, next adding sufficient sodium hydroxide to completely neutralize the acid solution and at the same time generate sufficient heat to melt an additional quantity of the solidified paraffins which may be present and finally withdrawing the entire reaction mixture from the well. On page 2, lines 59 to 63 of his patent, Tilton states

> "If desired, potassium dichromate may be added to the acid. The function of the dichromate is to dissolve the final film of greasy material adhering to mineral matter in the well."

Tilton does not disclose the use of an agent capable of inhibiting the action of acid upon metal apparatus which may be present within a well. The dichromate which he mentions is employed as a corrosive agent toward paraffin matter and it has previously been shown by the quotation from the Bulletin No. 233 of the U. S. Bureau of Mines that a chromate or dichromate is not capable of inhibiting the

corrosive action of acid upon metals which may be present inside of an oil well. Tilton then does not anticipate applicant's invention.

Coggeshall treats an oil well with a solution capable of displacing oil from sand grain structures in the strata at the bottom of the well. As a colloidal solution suitable for such purpose he prefers to employ an alkaline aqueous solution containing a hydrocarbon sulfonic acid. He does not show such sulfonic acid to be an agent capable of inhibiting corrosion of iron. To the contrary it is well known that sulfonic acids as a class are comparable in strength with strong mineral acids and it would be expected that such acids would be corrosive to iron, not corrosion inhibiting agents. That sulfonic acids actually are corrosive to iron is clearly shown on page 2, lines 38 to 45 of the De Groote patent No. 1823439, wherein it is stated

> "As is obvious, the reagent can be employed as an acid mass, that is, as the *sulfonic acid*. However, this is not desirable, due to the corrosive action of such acidic material. Therefore, it is desirable that the acidic material . . . be neutralized with a suitable alkali."

Coggeshall then has not disclosed the treatment of a deep well with a mixture consisting of a strong mineral acid and an agent capable of inhibiting the action of said acid upon metals and therefore does not anticipate the present invention.

De Groote in each of his cited patents No. 1823439 and No. 1823440 respectively, describes a method of cleaning oil bearing strata of the earth by forcing solutions through the same from one well to another, said solutions being capable of removing oil surfaces which tend to adhere to sand grains. In the first of the above patents, he employs an aqueous solution containing a salt of an alkylated aromatic sulfonic acid for such purpose. It has previously been mentioned in the discussion of the Coggeshall patent, that De Groote points out on page 2, lines 33 to 45 of his patent No. 1823439 that such sulfonic acids should be neu-

tralized with an alkali before being used as the free sulfonic acids are highly corrosive. DeGroote does not mention the use of an acid solution containing an agent capable of inhibiting the action of the acid upon metals as a cleaning agent for wells, hence, does not anticipate the invention. The second of the De Groote patents i.e. patent No. 1823440, employs an aqueous solution containing "wood sulfite liquor" for cleaning oil bearing strata of the earth in a manner similar to that described above. On page 2, lines 5 to 10 of said patent it is stated

> "We prefer to neutralize it (wood sulfite liquor) prior to use in our process, so that the oil recovered by the process will not have a destructive corrosive action on the pipe lines, tank cars, or storage tanks in which said oil is subsequently confined."

De Groote then shows clearly that the wood sulfite liquor which he employs is corrosive to iron hence is not comparable with the inhibiting agents disclosed in the present application.

In the last Office action, it is stated

> "Furthermore, any dissolved chloride would operate as an inhibitor by suppressing the dissociation of the hydrochloric acid, and such chlorides would inevitably be present."

The accompanying affidavit of one of the inventors, John J. Grebe, is submitted to show that sodium chloride has no practical value as an agent for inhibiting the action of hydrochloric acid on iron. From the data presented in said affidavit, it may be seen that between 36 and 56 times as much iron was corroded in the presence of a 15% hydrochloric acid solution *saturated* with sodium chloride as was corroded in the presence of 15% hydrochloric acid solution containing a relatively small quantity of one of the inhibiting agents disclosed in the present application.

Hydrochloric acid is one of the strongest of all known mineral acids and sodium chloride cannot be dissolved in aqueous hydrochloric acid in amount sufficient to suppress

the ionization of the acid to such extent as to prevent it from reacting with iron or steel. The relatively small amount of brine, which may be present in an oil well, would have no appreciable action in suppressing the ionization of a hydrochloric acid solution. *Neither sodium chloride nor other metal chloride may be employed successfully to inhibit the action of hydrochloric acid upon iron or steel and if they could be so employed they would,* at the same time, *inhibit the action of said acid upon the calcareous rock with which it is intended that it shall react.* Metallic chlorides, then, cannot be employed in place of the inhibitors disclosed in the application, hence the fact that such chlorides are sometimes present within a well does not invalidate patentability of any claim in the application.

In the conference courteously accorded counsel for applicants on August 12, 1932, the Examiner suggested that authoritative opinions, decisions and patents showing the allowability of claims similar to claim 7 of the present application be pointed out in the response to the last Office action. The Examiner's attention is accordingly directed to the following authoritative opinions and patents:

1. Patent Claim Drafting—Stringham—Page 65. Inventions involving chemical principles may be defined according to the principles that determine the utility if the inventor has ascertained these principles. - - - The rule that an invention may be defined by its principle seems particularly applicable in chemical, quasi-chemical and composition cases.

2. Ibid—Page 116.

A composition may be defined by its properties or its ingredients.

3. Ex parte Sperr, 12 U. S. Pat. Q. 194. Claim including "catalyst effective in causing the conversion of said impurities after absorption," etc., held not too indefinite where applicant named several examples in specification since it leaves others free to search for other processes based on different principles than use of catalyst.

4. Patent Office Practice by McCrady—Page 82. "In

Ex Parte Hamilton, 85 O. G. 1742, 1898 C. D. 273," the Commissioner said:—

> "Applicant can not be permitted to use in his claims terms which are indefinite and general in their meaning without such qualifying words as shall make clear what is intended to be covered by them and shall be expressive of the purpose, location or function of the elements intended. - - - The specification is the dictionary which is to be used in interpreting the claims and if the terms of the claim are clear after reading the specification that is all that is necessary."

5. The following patents were issued during the year 1932. Each of said patents contains claims which specify a substance by its properties rather than by its name:— 1,843,376; 1,843,783; 1,850,997; 1,851,151; 1,851,362; 1,851,-363; 1,851,411; 1,851,565; 1,851,607; 1,851,754; and 1,851,-844. Of the above patents, Patent No. 1,851,565 is particularly pertinent and contains a claim having the following terminology:—

> "The method of recovering oil from underground strata in a well which includes projecting a stream of *liquid capable of breaking down the surface tension between the oil and the inert materials to free the oil from* the inert material, etc."

In view of the above authoritative opinions and issued patents, it is thought that the wording of the generic claims of the present application is in accordance with that usually considered proper by the Patent Office.

It has previously been pointed out that each of the rejected claims 1, 5, 7, 8, and 9 distinguishes from the references in specifying that the hydrochloric acid used for increasing the flow of a well shall contain an agent capable of inhibiting the action of said acid upon metals. Each of said claims is thought to describe the invention correctly and to be in proper form for allowance.

Claim 1 is generic to all claims in each of the divisions required in the last Office action, hence it is thought that the requirement of division should be lifted.

Each claim in the application is thought to describe an invention which is patentably distinct from the cited references and all claims are thought to be in proper form for allowance.

Respectfully,
Thomas Griswold, Jr.,
Attorney.
by H. A. Stearns

AFFIDAVIT

State of Michigan, County of Midland, ss.

I, John J. Grebe, the undersigned, being duly sworn, depose and say that I am by profession a physicist, having been graduated from the Case School of Applied Science in 1924 with the degree of B.Sc. in physics, and from the same school in 1928 with the degree M.Sc. in physics; that I am co-inventor with Ross T. Sanford for the above application for "Treatment of Deep Wells"; that the following experiments have been made in order to compare the utility of various corrosion inhibitors, disclosed in the above application, as agents to prevent attack of aqueous hydrochloric acid upon iron with the utility of sodium chloride for similar purpose:

Several iron plates of similar composition, size, and form were weighed, then the plates were separately immersed in the following respective solutions: a 15 per cent hydrochloric acid solution containing 10 cubic centimeters of ethyl mercaptan per liter of solution, a 15 per cent hydrochloric acid solution containing 10 cubic centimeters of n-butyl mercaptan per liter, a 15 per cent hydrochloric acid solution containing 10 cubic centimeters of n-heptyl mercaptan per liter, a 15 per cent hydrochloric acid solution containing 5 cubic centimeters of arsenic acid per liter, and a 15 per cent hydrochloric acid solution saturated with sodium chloride. Each test plate was permitted to remain

immersed in its respective acid solution for a measured and weighed. From the difference in weight of each plate before and after the acid treatment it was calculated that the rate of corrosion of iron, expressed as pounds of iron lost per square foot of iron surface per 24 hours, in the various solutions was the following:

15 per cent aqueous HCl containing	Pounds of iron lost through corrosion per square foot of surface per 24 hours
Ethyl mercaptan	.0332
n-Butyl mercaptan	.0321
n-Heptyl mercaptan	.0210
Arsenic acid	.0210
Sodium chloride	0.190

John J. Grebe

Sworn to and subscribed before me this 11th day of August, 1932.

Geneva Turner

My commission expires July 7, 1934.

DEPARTMENT OF COMMERCE
United States Patent Office
Washington

kra kh/d (Mailed Aug 15 1932)

Please find below a communication from the EXAMINER in charge of this application.

Thos. Griswold, Jr.;
c/o The Dow Chemical Co.;
Midland, Mich.

Responsive to letter of August 13, 1932.

Additional references made of record:

Laverty	856,644	June 11, 1907	148/8
Vogel	1,433,579	Oct. 31, 1922	"
"	1,460,395	July 3, 1923	"
Gravell	1,678,776	July 31, 1928	"
Chamberlain	1,719,167	July 2, 1929	"
Fischer	1,736,282	Nov. 19, 1929	"
Vignos	1,750,651	Mar. 18, 1930	"
Bertleff	1,757,829	May 6, 1930	"

Claims 1, 5, 7, 8, and 9 are rejected on Ranney et al in view of De Groote 1,823,439 which describes the use of sulphonates instead of sulphuric acid, the organic radical in the latter case acting as an inhibitor. That it will act in this manner is clearly explained in the above cited patents to Laverty, Vogel 1,433,579, Fischer, and Bertleff. Whether De Groote knew about this inhibiting action or not is immaterial. The use of an acid mixture is clearly described by De Groote in lines 38 and 39 of page 2 of his specification. The use of the alkaline substances described further on in his specification is only an additional safeguard against corrosion.

Claims 2, 3, 4, and 6 are rejected on either Ranney et al or De Groote in view of Gravell cited describing the use of arsenic to inhibit corrosion.

Claim 10 is rejected on either Ranney et al or De Groote in view of Vogel 1,460,395 or Chamberlain cited describing the use of nitrogenous organic bases to inhibit corrosion.

Claim 11 is rejected on either Ranney et al or De Groote in view of Vignos describing the use of an organic sulphur compound to inhibit corrosion.

C. F. Krafft,
Examiner.

Paper No. 7
(Mailed Aug 16 1932)

DEPARTMENT OF COMMERCE
United States Patent Office
Washington

Please find below a communication from the Examiner in charge of this application.

Thomas E. Robertson,
Commissioner of Patents.

Thos. Griswold, Jr.;
c/o The Dow Chemical Co.;
Midland, Michigan

In view of counsel's argument at the oral interview to the effect that applicant uses hydrochloric acid and not

sulphuric or sulphonic acid as in the references, it is thought upon reconsideration that the claims can be allowed. This application will therefore be passed to issue forthwith.

C. F. Krafft,
Examiner.

DEPARTMENT OF COMMERCE
United States Patent Office
Washington

August seventeenth, 1932

John J. Grebe, et al:

Your Application for a patent for an Improvement in Treatment of deep wells filed 6/30/32 has been examined and Allowed with 11 claims.

The final fee, Thirty Dollars, With $1 Additional For Each Claim Allowed in Excess of 20, must be paid not later than Six Months from the date of this present notice of allowance. If the final fee be not paid within that period, the patent will be withheld, but the application may be renewed within one year after the date of the original notice with a renewal fee of $30 and $1 additional for each claim in excess of 20.

The office delivers patents upon the day of their date, on which date their term begins to run. The preparation of the patent for final signing and sealing will require about four weeks, and such work will not be begun until after payment of the necessary final fee.

When the final fee is paid, there should also be sent, Distinctly And Plainly Written, the name of the Inventor, Title of the Invention, And Serial Number as Above Given, Date of Allowance (which is the date of this circular), Date of Filing, and, if assigned, the Names of the Assignees.

If it is desired to have the patent issue to an Assignee or Assignees, an assignment containing a Request to that effect, together with the Fee for recording the same, must be filed in this office on or before the date of payment of the final fee.

After issue of the patent, uncertified copies of the drawings and specifications may be purchased at the price of Ten Cents Each. The money should accompany the order. Postage stamps will not be received.

The final fee will Not be received from other than the applicant, his assignee or attorney, or a party in interest as shown by the records of the Patent Office.

Notice.—When the Number of Claims Allowed Is in Excess of 20, No Sum Less Than $30 Plus $1 Additional For Each Claim in Excess of Twenty Can Be Accepted as the Final Fee.

Respectfully,
Thomas E. Robertson,
Commissioner of Patents.

Thomas Griswold, Jr.;
c/o The Dow Chemical Co.;
Midland, Michigan.

Aug 17-32 575251A—Check 30.00
Rec'd U. S. Patent Office

FINAL FEE PAID TO THE COMMISSIONER OF PATENTS

(Be careful to give correct Serial No.)

Serial No. 620,292
Inventors: John J. Grebe et al.
Patent to be issued to The Dow Chemical Co.
Name of Invention, as Allowed: Treatment of Deep Wells.
Date of Payment: August 17, 1932
Fee: $30.—
Date of Filing: June 30, 1932
Date of Circular of Allowance: August 17, 1932

The Commissioner of Patents will please apply the accompanying fee as indicated above.

Thomas Griswold, Jr.,
Attorney.

Defendant's Exhibit 312

DEPARTMENT OF COMMERCE
United States Patent Office
Washington

Aug. 25, 1932

Petition under Rule 78:

This petition is referred to Examiner in charge of Division 38 in accordance with Order No. 2698; Order No. 2801, 308 O. G., 447, and Notice of August 11, 1922.

Thomas E. Robertson,
Commissioner.

Washington, D. C., August 16, 1932.

Hon. Commissioner of Patents,
Sir:—

In re application J. J. Grebe, et al., "Treament of Deep Wells," Serial No. 620,292, filed June 30, 1932, the following changes are requested under the provisions of Rule 78.

AMENDMENT UNDER RULE 78

Claims 2 and 3, last line of each, and claim 6, line 4, after "compound" insert—*capable of inhibiting action of the acid upon metals*—.

REMARKS

During the course of an interview courteously accorded counsel for applicants on August 16, 1932, the Primary Examiner agreed that all claims in this application would be considered allowable, and that the above changes would be accepted under the provisions of Rule 78.

Respectfully,
Thomas Griswold, Jr.
by H. A. Stearns

Pat. 1877504

DEPARTMENT OF COMMERCE
United States Patent Office
Washington

Thos. Griswold, Jr;
c/o The Dow Chemical Co.;
Midland, Mich.

The amendment proposed has been entered under Rule 78.

Thomas E. Robertson,
Commissioner of Patents.

(Mail Room Jan 24 1934 U. S. Patent Office) #10

UNITED STATES DISTRICT COURT
District of Eastern Oklahoma

Honorable Commissioner of Patents,
Washhington, D. C.

Sir:

In compliance with the Act of February 18, 1922 (41 Stat. L. ...), you are advised that there was filed on the 18th day of January, 1934, in this court an action, suit, or proceeding No. 4523-Equity, entitled:

Name The Dow Chemical Company, a corporation, Plaintiff,
Address Midland, Midland County, Michigan,

versus

Name The Chemical Process Company, a corporation,
Defendant,
Address Breckenridge, Texas. (Domesticated in State of Oklahoma, with place of business at Seminole, Seminole County, Okla.)

brought upon the following patents:

Patent No.	Date of Patent	Patentee
1,877,504	Sept. 13, 1932	The Dow Chemical Company, assignee

In witness whereof I have affixed my hand this 22nd day of January, 1934; at Muskogee, Oklahoma.

W. V. McClure, Clerk of said Court.
(Seal) By Larry Grimm, Chief Deputy.

Defendant's Exhibit 312

(Mail Room May 7 1934 U. S. Patent Office) #11

DISTRICT COURT OF THE UNITED STATES
Northern District of Oklahoma

Honorable Commissioner of Patents,
Washington, D. C.

Sir:

In compliance with the Act of February 18, 1922 (42 Stat. L. 392), you are advised that there was filed on the 4th day of May, 1934, in this court an action, suit, or proceeding No. 968 Eq., entitled:

Name The Dow Chemical Company, a corporation, Plaintiff,
Address Midland, Midland County, Michigan

versus

Name Williams Brothers Well Treating Corporation,
a corp., Defendant.
Address Tulsa, Tulsa County, Oklahoma,

brought upon the following patents:

Patent No.	Date of Patent	Patentee
1,877,504	Sept. 13, 1932	John J. Grebe and Ross T. Sanford.

In witness whereof I have affixed my hand this 4th day of May, 1934, at Tulsa.

H. P. Warfield, Clerk of said Court,
By M. M. Ewing, Deputy.

(Mail Division Jun 1-35 U. S. Patent Office) 12

UNITED STATES CIRCUIT COURT OF APPEALS
Tenth Circuit

Honorable Commissioner of Patents,
Washington, D. C.

Sir:

In compliance with the Act of February 18, 1922 (42 Stat. L. 392), you are advised that there was filed on the 28th day of May, 1935, in this court an action, suit, or proceeding No. 1285, entitled:

Defendant's Exhibit 312

Name The Dow Chemical Company, Appellant,
Address Midland, Michigan,

versus

Name Williams Brothers Well Treating Corporation,
Address Tulsa, Oklahoma, Appellee,
brought upon the following patents:

Patent No.	Date of Patent	Patentee
1,877,504	Sept. 13, 1932	John J. Grebe and Ross T. Sanford.

In Witness Whereof I have affixed my hand this 29th day of May, 1935, at Denver, Colorado.

Albert Trego,
Clerk of said Court.

(Mail Division Jan 16 36 U. S. Patent Office) #13

UNITED STATES CIRCUIT COURT OF APPEALS
Tenth Circuit

Honorable Commissioner of Patents,
Washington, D. C.

Sir:

In compliance with the Act of February 18, 1922 (42 Stat. L. 392), you are advised that there was filed on the 28th day of May, 1935, in this court an action, suit, or proceeding No. 1285, entitled:

Name The Dow Chemical Company, Appellant,
Address Midland, Michigan,

versus

Name Williams Brothers Well Treating Corporation,
Address Tulsa, Oklahoma,
brought upon the following patents:

Patent No.	Date of Patent	Patentee
1,877,504	Sept. 13, 1932	John J. Grebe and Ross T. Sanford.

In the above-entitled case the following decision has been rendered or decree issued: Decree of the District Court reversed on January 10, 1936.

In Witness Whereof I have affixed by hand this 13th day of January, 1936, at Denver, Colorado.

Albert Trego, Clerk of said Court.
By H. A. McIntyre, Deputy Clerk.

DEFENDANT'S EXHIBIT 314

Disclosure No. 1173
Date, June 1, 1932 Case No. 850G

THE DOW CHEMICAL COMPANY

INVENTION CONCEPTION DATA SHEET

"When an invention is conceived—put it in writing, sign, date and have witnessed."

A. Name of Inventor(s)—J. J. Grebe.

B. Title of Invention—Mining Soluble Minerals with Acid.

M. Description of Invention—A charge of acid is placed in the bore in contact with an acid-soluble formation, such as limestone, dolomite, magnesite, or a like basic mineral, and permitted to react until CO_2 is no longer formed. The acid is then pumped out and pumpage of oil or other fluid mineral is continued when it is found that the output thereof has increased. Specifically, employ hydrochloric acid to which has been added enough arsenic to prevent substantial attack upon the iron tubing when the procedure may be as follows:—

The rods may be withdrawn from the pump-tube and the acid run down the tube, enough being used to fill the hole to cover the formation to be attacked. If desired, more acid may be added or the tube and casing may be sealed off to cause the gas pressure developed to force the acid into the stratum being attacked.

It is preferable to shoot the well with a small charge before treating with acid in order to extend the action of the acid into fissures in the rock, thereby opening up the flow lines.

Although it has been known for a long time that hydrochloric acid containing arsenic would not attack iron to any great extent, yet the use of an acid to open up a well, specifically an acid containing arsenic, is believed to be new. The strength of the acid should be adjusted to a gravity such that the resulting solution will dissolve the salts formed.

Inventor(s) John J. Grebe, July 2, 1932.

STIPULATION RE CONTENTS OF APPEAL RECORD

It is hereby stipulated by and between counsel for the parties hereto that the printed record herein, consisting of three volumes of testimony and proceedings and one volume of exhibits, pages 1 to 2048, inclusive, may be accepted as the complete record of testimony, proceedings and exhibits in the District Court in this cause, for the purposes of appeal, and that all exhibits printed in whole or in part in this record and all other exhibits which were given exhibit numbers in this case by the clerk of the District Court were duly offered and received in evidence.

It is further stipulated that the following exhibits shall be sent up as physical exhibits to the clerk of the Sixth Circuit Court of Appeals for use at the hearing and in the disposition of this appeal:

DX-11
DX-11½
PX-15
DX-16
PX-17
PX-18
PX-22
PX-24, 25
PX-28–30
PX-32, 33
PX-35, 36
PX-69
PX-70
DX 75-82
DX-84
DX-85
DX-87
DX-89
DX-91
DX-92
DX-95-98
DX-100
DX-106
DX-107
DX-116–131
DX-133–137
PX 168
PX-184–186
PX-190
DX-191
PX-193–215
DX 216
PX-217
DX-221–227
PX-228–230
PX-244
PX-247, 248
DX-277–279
DX-280–286
DX-290-293, 295
DX-296, 297-299
PX-306-308
PX-310
PX-317, 317A
PX-318, 318A
PX-319, 319A
PX-327
DX-332
PX-338-341
PX-343-346
PX-352
PX-355, 356
PX-359
PX-361
PX-365

October 27, 1942.

Wilber Owen,
Counsel for Plaintiff.

Earl Babcock,
Counsel for Defendant.

CERTIFICATE OF CLERK

United States of America,
Eastern District of Michigan, Northern Division, ss.

I, George M. Read, clerk of the United States District Court within and for said district, do hereby certify that the foregoing printed pages numbered 1 to 2048, inclusive, contain a true and complete copy of the record and proceedings in this cause, including a copy of the judgment appealed from, a copy of the notice of appeal with its filing date, and a concise statement of the points to be relied on by the appellant, in accordance with the stipulation of the parties, dated October 27, 1942, on file in this office.

In testimony whereof I have hereunto signed my name and affixed the seal of said court at Bay City, in said district, this 31st day of October, 1942, and in the One Hundred Sixty-Seventh year of the Independence of the United States of America.

George M. Read, Clerk,

(Seal) By Clarence S. Pettit, Deputy Clerk.

PROCEEDINGS IN THE
UNITED STATES CIRCUIT COURT OF APPEALS
FOR THE SIXTH CIRCUIT

CAUSE ARGUED AND SUBMITTED

(October 11, 1943—Before ALLEN, HAMILTON and MARTIN, JJ.)

This cause is argued by Wilbur Owen for Appellant and by Leonard S. Lyon and Earl Babcock for Appellee and is submitted to the court.

DECREE

(Entered December 17, 1943)

Appeal from the District Court of the United States for the Eastern District of Michigan.

This cause came on to be heard on the transcript of the record from the District Court of the United States for the Eastern District of Michigan, and was argued by counsel.

ON CONSIDERATION WHEREOF, it is now here ordered, adjudged and decreed by this Court that the decree of the said District Court in this cause be and the same is hereby affirmed.

OPINION

(Filed December 17, 1943)

Before ALLEN, HAMILTON and MARTIN, Circuit Judges.

ALLEN, Circuit Judge. This appeal attacks a decree finding invalid for want of invention Grebe & Sanford patent 1,877,504, of which appellant is assignee. The patent covers a method and process of "treatment of deep wells." By stipulation of the parties two other patents relating to the same subject, Grebe, 1,916,122, and Grebe & Stoesser, 1,998,756, were sustained, and the court found that the appellee infringed certain of the claims of each of them. The complaint was dismissed as to Chamberlain patent 2,024,718, but appellant has not questioned this action here. A counterclaim filed under Gravell patent, 1,678,775, was dismissed, the patent being held invalid, and no appeal was taken by appellee.

The Grebe & Sanford patent is especially concerned with the treatment of deep oil wells in which the mineral-bearing stratum consists of limestone or other calcareous formation, such as dolomite. The specifications state that the object of the invention is to increase the output from deep wells and to counteract some preventable natural causes for the decline of yield of a well, such as arise from the lack of sufficient ground pressure to cause the well to flow or from the building up of deposits of wax and other foreign substances in the channels of the oil-bearing rock which obstruct and may even cut off the flow of oil to the well. Among other methods for opening up a clogged well-hole the specifications particularly discuss that disclosed in Frasch patent, 556,669, for increasing the flow of an oil well in a limestone formation by treating it with acid, such as hydrochloric acid. The Grebe & Sanford specifications declare that "The acid has the effect of attacking and dissolving the rock, thereby enlarging the cavity at the bottom of the well, or the channels and pores in the rock through which oil flows to the well," but state that in actual practice this method has never been generally adopted, due to the fact that the acid attacks and damages the metallic casing and the pump tubes.

The claim is then made that the patent presents an improved method of using the hydrochloric acid treatment, which consists of adding to the acid a small amount of a substance capable of inhibiting attack of the acid on metal surfaces with which it comes in contact. For the inhibiting agent the use of an arsenic compound of from one to five per cent, based on the weight of the solution, is recommended. Numerous other inhibitors are also suggested. The recommended strength of the aqueous hydrochloric acid solution is between about five per cent and about twenty per cent, preferably between ten and fifteen per cent.

Claims 1, 5, 7, 8, and 9 are in suit. Claim 8 is typical and reads as follows:

> "8. The method for increasing the output of an oil well which comprises charging into the pump tube a quantity of a 5 to 20 per cent hydrochloric acid solution containing a relatively small amount of a corrosion inhibitor, expelling the acid from the tube into the bore of the well by applying pressure thereon, permitting the acid to act upon the rock formation surrounding the well cavity and withdrawing the spent acid."

The District Court found that the appellant in 1932 was the first to treat the producing formation of a limestone well with inhibited hydrochloric acid charged into the well through the pump tube, and that the appellee inhibits the hydrochloric acid used in its business of treating wells by the presence in the acid of dissolved lead and copper. However, the District Court dismissed the bill upon the ground that in adding a corrosion inhibitor to hydrochloric acid for use in acidizing wells, Grebe & Sanford were merely making use of the well-known qualities of such corrosion inhibitors without obtaining any new or unexpected result, and without creating any new process of acidizing a limestone formation. The court found that the addition of the corrosion inhibitor, in view of the prior art, required no more than

the ordinary skill of the calling and involved no patentable invention.

The appellee's acid in its initial state has no inhibitor added to it. It is transported to the wells in steel containers on the inside of which a number of lead sheets are brazed. A battery action is thereby set up and minute quantities of copper, lead and iron chlorides are deposited on the inside of the steel container, forming a protective coating. An acid solution of about fifteen per cent concentration is used by the appellee, and when the acid is inserted in the tubing of the well, the copper, lead and iron chlorides therein act to reduce corrosion from forty to sixty per cent. Although no chemical action is present between the hydrochloric acid and the arsenic compounds which are used by appellant as inhibitors, as is the case in appellee's process, the District Court found, we think correctly, that appellee infringes if the patent is valid. There is no substantial difference between the results secured by the appellee and that secured by appellant, and the method used is essentially the same.

The patent in suit was involved in a case heard in the Circuit Court of Appeals for the Tenth Circuit, *Dow Chemical Co.* v. *Williams Bros. Well Treating Corp.*, 81 Fed. (2d) 495. There the patent was held valid, and appellant relies largely upon that decision to support its contention that the decree must be reversed. The District Court found in the instant case that the method of acidizing disclosed in the Frasch patent, 556,669 (1896), was successfully used on a commercial basis in the acidizing of wells near Lima, Ohio, in 1895; that inhibited hydrochloric acid was used by the Gypsy Oil Company in 1928 to remove calcareous scale from pipe and equipment in certain wells, and that this use was reduced by the Gypsy Oil Company to successful commercial practice. The court found that many wells have been acidized successfully with commercial hydrochloric acid using no corrosion inhibitor both before and since the patent issued to Grebe & Sanford, and that during a great majority of the usual commercial acidizing operations the rate of corrosion of raw commercial hydrochloric acid upon steel

does not result in any material damage to the well pipe or equipment. All of these findings of fact are challenged by appellant on the ground that the Court of Appeals of the Tenth Circuit made diametrically opposite conclusions in the *Williams Bros.* case, *supra*, and that they are not supported by the evidence.

We think that each of these findings of fact is supported by substantial evidence. While the court in the *Williams Bros.* case decided that the Frasch method was cumbersome and impracticable, and that an alleged prior use by the Gypsy Oil Company in 1928 was no more than an unsuccessful and abandoned experiment, that court did not have the advantage of testimony presented in the instant case. We agree with the District Court that the evidence herein compels a different conclusion.

With reference to the use of the Frasch method, it clearly appears from the evidence, none of which was presented in the *Williams Bros.* case, that the Frasch method was used extensively in the oil fields of Lima, Ohio, in 1895 and 1896. The gist of Frasch's invention was the application of hydrochloric acid to limestone formations for the purpose of opening and broadening the channels in the rock through which the oil would run into the well. Frasch calls his invention "a method of increasing the flow of oil wells in limestone formations." He especially recommends the use of hydrochloric or muriatic acid to open the channels in the limestone because these acids dissolve the rock itself and the product of the chemical reaction does not remain to obstruct the passages.

Frasch recognized that hydrochloric acid would corrode the equipment. He not only suggested the use of a packer around the tubing, which was criticized in the *Williams Bros.* case, but also the use of enameled or lead-lined pipe to conduct the acid into the well, and the use of an alkaline liquid to neutralize the acid after it had performed its function, thus eliminating corrosion. None of the nine claims of Frasch mentions the packer or specifies any means of reducing corrosion. Frasch was concerned only incidentally with this problem. His essen-

tial conception was to attack the limestone rock with a chemical reagent which would disintegrate the rock, increase its porosity, and open the channels into the pay. In this he fully succeeded.

The use of Frasch's invention increased the production of oil wells in limestone formations by large percentages. The increase in production of one well in the Lima field, due to use of this method in 1895, was three hundred per cent, and was stated to be permanent, and a number of other wells in that field, after being treated with hydrochloric acid under this method, showed a remarkable increase. In June, 1932, the Oil Makers Company began to acidize wells in Michigan and treated many wells successfully with uninhibited hydrochloric acid. The superintendent of the McClanahan Oil & Gas Company testified that a number of these operations resulted in "a nice increase" of oil, most of them without damage to the equipment. The Oil Makers Company was compelled to suspend business, not as appellant urges, because of lack of success, but because of lack of capital, the falling price of oil, and letters written by appellant threatening to sue the company and its customers for "use of acid in any manner" which would infringe the patents. The Oil Makers Company construed this to mean that it would be sued if it used raw acid, that is acid containing no inhibitor.

The Chemical Process Company since 1932 has successfully acidized 15,000 wells, serving most of the major oil companies and using in almost all instances raw acid. Thus it has been employing the Frasch method.

The Gypsy Oil Company prior use of 1928 and 1929, found by the District Court to anticipate the patent in suit, although held in the *Williams Bros.* case to be an "unsuccessful and abandoned experiment," appears from the evidence here to have been a complete "scientific success." It involved the use of inhibited hydrochloric acid to clean scale from well equipment in sandstone formation. Appellant's endeavor to establish that this prior use is not material because it was employed in sandstone formation instead of in limestone has no weight, for con-

cededly appellant's invention, if there is invention, relates solely to the protection of the well equipment from corrosion by the acid, and not to the action of the acid upon the rock. This was the relevant part of the problem presented in the treatment of these wells in sandstone formation, and hence if the prior use is established it anticipates.

In 1928, the Mellon Institute was requested to advise the Gypsy Oil Company, a division of Gulf Oil Co., as to the proper solvent for dissolving the scale which formed inside the tubing of certain wells and impeded their operation. Dr. Blaine B. Wescott made a report on behalf of the Institute, suggesting the use of hydrochloric acid as solvent. Recognizing that some of the metal of the tubing, casing and sucker-rods would be lost in the acid, the report proposes the use of an inhibitor such as is employed in the steel mills, and suggests Rodine #2 for the purpose. The William Berryhill well No. 8 was treated by this method in 1928, with complete success, and similar successful treatments of other wells followed into 1931. The treatment of the Anderson well No. 3, stressed by appellant, involved an attempt not to remove scale, but to prevent its formation by a treatment not recommended in the report, and was not successful. While the Gypsy Oil Company discontinued these treatments, due to the very low price of oil at that time, the company felt that it was accomplishing the results desired, and the treatments can not be dismissed as an "experiment" or as being "abandoned." The practicability of the method recommended by the Institute was completely established and its utility demonstrated over a sufficient period to constitute a prior use. Cf. *Corona Cord Tire Co.* v. *Dovan Chemical Corp.*, 267 U. S. 358, 384. Moreover, the testimony of Dr. Wescott, which was not before the Tenth Circuit, shows that the use of inhibitors to protect metal from hydrochloric acid was well understood at that time so that in that respect no problem whatever was presented for solution. The use of the inhibitor in conjunction with the acid was suggested by the Institute as a matter of course.

The record is replete with testimony not presented in

the *Williams Bros.* case, to the effect that the use of an inhibitor is not necessary to the successful acidization of an oil well. One expert states that the inhibitor cost more than the damage to the equipment would have amounted to had raw acid been used. Since the adjudication of the *Williams Bros.* case in 1936, the Gypsy Oil Company has treated all of its wells with uninhibited acid and the record of the Chemical Process Company is cogent evidence in support of the finding of fact of the District Court upon this point.

Under the findings of fact, therefore, a very narrow question is presented upon the issue of validity. The Tenth Circuit considered that the question of patentability of Grebe & Sanford revolved around the problem of the increase in the flow of the well. It stated in effect that this process increased the ultimate recovery from the sand, and that the production of more oil in a more efficient way is accomplished by the patent in suit. It concluded that the acid without the inhibitor had proven to be a failure, and held that Grebe & Sanford "conceived the idea of dissolving the formation in which nature stored its oil." But the patent itself recognizes the fact that this idea was conceived by Frasch, and that increase in production was obtained by the Frasch method; and in the instant case appellant's expert stated that the inhibitors "would have no effect on the acid in connection with its reaction upon limestone," and that the result "would be limited apparently to the equipment, rather than to the well itself." Hence under appellant's own testimony the increase in the flow of the well is not the problem claimed to be solved, for since the addition of the corrosion inhibitor to the hydrochloric acid does not affect the action of the acid upon the limestone, no new process is created. The object of the invention, as stated by appellant's expert, is simply to protect the equipment from the hydrochloric acid. The single question is whether the conception of adding a corrosion inhibitor to hydrochloric acid for use in acidizing wells in order to reduce corrosion requires anything more than the ordinary skill of the calling or involves any patentable invention.

All the elements of the claimed combination were old. It was old to increase production by the use of hydrochloric acid under pressure. The use of this very process was suggested to Grebe & Sanford by the Pure Oil Company prior to the issuance of the patent in suit and was not original with them. It was old to use inhibitors with hydrochloric, phosphoric, and other pickling acids to reduce corrosion on iron and steel. Cf. Patent to Beneker, 914,916 (1909); Patent to Holmes, 1,470,225 (1923); Patent to Gravell, 1,678,775 (1925). The use of inhibitors other than those based on arsenic is shown in Fischer & Stegemeyer, 1,736,282 (1929); Rhodes, 1,746,677 (1930); Vignos, 1,750,651 (1930); Harrison, 1,766,902 (1930). Scientific publications, describing the use of inhibitors, are in evidence, dating from 1845. The only novel element here was that appellant first charged the inhibited hydrochloric acid into the limestone formation through the pump tube. The application of these two old principles to an oil well and the obvious step of conducting the acid through the pump tubing did not constitute invention, in view of the prior art as presented in this case. All that was required was expected mechanical skill. No new result was achieved. Cf. *Grinnell Washing Machine Co.* v. *Johnson Co.*, 247 U. S. 426, 433, 434.

While appellant attacks the specific findings of the District Court which hold that the method of increasing the flow in the oil well was old and widely known, it relies here, as it did in the *Williams Bros.* case, upon commercial success to establish invention. The extensive commercial success of appellant is at least partly referable to the phenomenal growth of the demand for oil during the last few decades, and to appellant's powerful business organization. But patent monopoly is granted not for commercial success, but for novelty and invention. Commercial success of itself does not create invention. Cf. *Paramount Publix Corp.* v. *American Tri-Ergon Corp.*, 294 U. S. 464. Commercial success is only a factor entering into the decision, when the question of invention is open to doubt. *Bulldog Electric Products Co.* v. *General Electric Co.*, 105 Fed. (2d) 466 (C. C. A. 4). Here the question is

not open to doubt, for even the alleged meritorious results appear not to have been demonstrated. When invention does not exist commercial success is immaterial. *Grosjean* v. *Panther-Panco Rubber Co.*, 113 Fed. (2d) 252 (C. C. A. 1); *Evr-Klean Seat Pad Co.* v. *Firestone Tire & Rubber Co.*, 118 Fed. (2d) 600 (C. C. A. 8); *Rid-Jid Products, Inc.*, v. *Rich Pump & Ladder Co.*, 103 Fed. (2d) 574 (C.C.A. 6).

The decree is affirmed.

PETITION FOR REHEARING

(Filed January 17, 1944)

IN THE

United States Circuit Court of Appeals

FOR THE SIXTH CIRCUIT

No. 9392

THE DOW CHEMICAL COMPANY, A CORPORATION,
Plaintiff-Appellant,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY,
A CORPORATION,
Defendant-Appellee.

PETITION FOR REHEARING

The Dow Chemical Company, appellant, respectfully petitions Your Honors to grant it a rehearing in this cause for the reasons hereinafter set forth.

It is respectfully urged that the opinion of this court in holding invalid the patent in suit, previously held valid by the Tenth Circuit Court of Appeals in the case of *The Dow Chemical Company vs. Williams Brothers Well Treating Corporation*, 81 Fed. (2d) 495, has misapprehended the effect of the new evidence in this record and has failed to apply long recognized principles of patent law. In view of the propriety in the instant case of a writ of *certiorari* by the Supreme Court to resolve the conflict between the decision of this court and that of the Tenth Circuit Court

of Appeals, it would seem proper that we point out the record facts which, in our judgment, require a reversal of the decree of the District Court herein.

Statement

The court recognized that appellant "was the first to treat the producing formation of a limestone well with inhibited acid charged into the well through the pump tube" (Opinion, p. 2), yet held that this did not require anything more than the ordinary skill of the calling or involve any patentable invention (p. 6). It based its departure from the ruling of the Tenth Circuit Court of Appeals primarily on the theory that evidence presented here and not before the court in the Tenth Circuit compelled a different conclusion on the question of validity.

We will first consider the character and effect of the new evidence and will then consider the court's conclusion that what Grebe-Sanford did required nothing more than the ordinary skill of the calling and did not involve invention.

The new evidence may conveniently be classified as follows:

1. That relating to the use of the process of Frasch patent 556,669 in approximately a dozen wells in the Lima, Ohio, oil field in 1895 and 1896.

2. That relating to the acidizing of oil wells with raw hydrochloric acid subsequent to the invention and public use of the process of the patent in suit.

3. That relating to the use of inhibited hydrochloric acid to remove deposits of gyp from the tubing in sandstone wells of the Gypsy Oil Company in the Glenpool in Oklahoma during the period 1928 to 1931.

On each of these points we respectfully submit that the court either has misconstrued the evidence or has drawn incorrect conclusions therefrom, as we shall now endeavor to point out.

I. The New Evidence Regarding Frasch

This evidence is that the process described in the Frasch patent was tried in approximately a dozen wells in the Lima, Ohio, limestone field during a period of less than two years beginning in October, 1895, and that substantial increases in production resulted from some of those treatments.

The statement of the court that Frasch "fully succeeded" in his conception of attacking the limestone rock with a chemical reagent so as to increase production is refuted by the history of the art, which shows that no practical use was ever made of Frasch's conception after 1896.

Insofar as any benefit to the public or the oil industry was concerned Frasch's patent may as well never have issued and the soundness of his conception that hydrochloric acid would attack oil bearing limestone formation, increase its porosity and open new channels may as well never have been demonstrated, for he failed to provide a practicable method of applying his discovery as evidenced by its complete abandonment after a few trials.

The very success of the early Frasch experiments in demonstrating that the production of oil from limestone formations could be increased, followed by non-use for thirty-five years, is in itself cogent proof of the practical failure of his process.

The fact that the correctness of Frasch's conception was demonstrated in a few wells adds nothing to the patent

disclosure as a reference against Grebe-Sanford. The patent states that the introduction of hydrochloric acid into oil producing limestone formation will eat away the limestone and increase the flow of the well. (R. 1936.)

The Tenth Circuit Court of Appeals and the Examiners in the Patent Office accepted these statements at their face value (as indeed they must have for they were also being urged by Grebe and Sanford) and reasoned from the disclosure of the Frasch patent that the Grebe and Sanford discovery involved that quality which characterizes it as invention rather than the expected skill of the art. The additional evidence here shows nothing more than that the Tenth Circuit Court reasoned correctly and it can form no proper basis for arriving at a different result.

When the Grebe-Sanford process was introduced and took the oil industry by storm, the Frasch process had been dead and forgotten over a third of a century. What stronger proof could there be that Frasch was a commercial failure, precisely as Judge McDermott reasoned it must have been in the absence of proof that it had gone into commercial use?

We respectfully submit that the distinction between commercial use and commercial success, as laid down by this court in *Motor Improvements vs. General Motors*, 49 Fed. (2d) 543, 545, is sound, and that an application of the principle there laid down would have resulted in a finding that the Frasch method as described in his patent and tried in the Lima field was a commercial failure.

Why Frasch failed may not be important, but it is significant that at the time he made his discovery and at all times since, the means by which Grebe and Sanford made his discovery commercially useful and valuable were readily available and did not depend on progress or new

discoveries in other arts. We respectfully submit that this court has erred in attributing any practical success to Frasch by reason of the short use of his process in the Lima oil field. The successful demonstration of a scientific fact by means of a process not commercially practicable should not be resorted to for the purpose of striking down a meritorious invention. The Frasch process for acidizing oil wells was no more complete or successful than would be the conception of an aeroplane which would fly but which could not land without damage to its equipment.

II. The New Evidence Regarding the Acidation of Wells With Raw Acid by Others Than Frasch

The record is absolutely silent as to any attempt to acidize an oil producing formation with hydrochloric acid between the date of Frasch's experiments in 1895-6 and the date of the Grebe-Sanford invention.

After the Grebe-Sanford process had been used quite extensively and with universal success in the Michigan oil fields in the spring and early summer of 1932, several men who had become familiar with that process undertook to acidize oil wells in the Michigan fields by the use of *raw* hydrochloric acid introduced directly through the pump tube. They called themselves the Oil Makers Company and acidized their first well on July 24, 1932, using only *raw* acid purchased from Pennsylvania Salt Manufacturing Company, of Wyandotte, Michigan. (R. 1259.) They so treated from 35 to 40 wells (R. 1225) and received complaints of damage to fully half of them. (R. 1203-12, 1259-69.) Because they received so many complaints they changed to the use of inhibited acid purchased from Grasselli Chemical Company of Cleveland. The first check to Grasselli for this acid was dated September 19, 1932, for

the sum of $475.00, and these purchases from Grasselli continued monthly thereafter until April of 1933 (R. 1199-1200), when they discontinued the business because of lack of capital and the falling price of oil. The president of the company testified (R. 1238):

> "* * * The reason that our company was unsuccessful and had to go out of business was that the price of oil went down in Texas and Louisiana. It was just impossible to make collections. No one wanted to treat their wells to increase production when they weren't getting enough money for their oil."

At the top of page 5 of the opinion the court erroneously assumes that this testimony refers to the discontinuance of the use of raw acid by the Oil Makers Company, whereas it actually refers to the discontinuance of the business of acidizing wells with *inhibited* hydrochloric acid purchased from the Grasselli Chemical Company and after it had been using that acid for more than six months. The undisputed testimony of those in control of the Oil Makers Company is that it discontinued the use of raw acid because of the extensive damage it was causing to well equipment.

Walter Sprenger, who had actual charge of the treatments with raw acid up to the time he quit the company about the middle of September, 1932, testified, after referring to a treatment made by him on September 12, 1932:

> "* * * That is the last well that I treated for this organization, and when I quit working for them I talked with my associates and told them that I was quitting. I told them that I believed that the business was too big for us. We were causing more damage than we were making money to pay for. I also told them that unless we found some way to use the acid without causing so much trouble to the steel material in the well, that it was useless to continue to use it. I talked to Mr. Charles Dougherty, Mr. Fred Markey and Edgar Lee."

Mr. Dougherty testified (R. 1226):

"All the troubles came from using raw acid."

And Lee testified (R. 1171):

"At the last we bought our acid from the Grasselli Chemical Company of Cleveland, Ohio. The Grasselli Company claimed that they had an inhibitor in their acid that would do away with the trouble that we had been having, and that was the reason we changed our source of supply for acid."

In spite of these proofs the opinion of the court clearly creates the inference that Oil Makers Company was successful in its business of treating wells with raw acid.

In further support of the finding that the treatment of wells with raw acid was commercially successful the court states that the Chemical Process Company "since 1932 has successfully acidized 15,000 wells, serving most of the major oil companies and using in almost all instances raw acid."

The only support for this finding is the uncorroborated testimony of an interested witness (Pitzer) whose company would be an infringer if he admitted that it used an inhibitor in its acid. That it used inhibited acid before the patent in suit was sustained in the *Williams* case is not denied, and the undisputed proofs show that rolls of lead plate have been found in a number of its truck tanks, the only possible purpose of which was to cause the formation of lead and copper chlorides in the acid, which are the identical inhibiting agents utilized by defendant in its present infringing process. Pitzer's denial of the use of inhibited acid is entitled to no more weight than was defendant's denial of infringement in this case. We proved that defendant's denial was not in accordance with the facts, and both the trial court and this court have held with us on the question of infringement. No proofs were offered

by defendant in support of Pitzer's statement that his company uses raw acid, and we had no opportunity to disprove that statement. No samples or analyses of Pitzer's acid were produced, yet the court accepted his uncorroborated statement in spite of the proof that his tanks contained rolls of sheet lead which inevitably would produce lead and copper chlorides in the acid.

The use of raw acid without any special protective equipment subsequent to the date of the Grebe-Sanford invention can have no direct bearing on the validity of the patent in suit. Furthermore, such use is not here in issue and is not charged to be an infringement of that patent.

Even if such subsequent use of raw acid was thought by the court to have an indirect bearing on the consideration of this case, the question for determination, we respectfully submit, is not whether in occasional instances or in some pools the acid passes through the tubing and into the formation so rapidly that no material damage results to the well equipment from the use of raw acid, but whether the *business* of acidizing wells with raw acid has ever been commercially successful. That it has not been commercially successful, whether the raw acid is introduced through a special tubing, as in Frasch, or through the regular well tubing, as attempted by the Oil Makers Company, is established by a strong array of undisputed facts:

1. Frasch tried it in 1895-6 and abandoned the effort after treating approximately a dozen wells.

2. Oil Makers Company tried it for two months in the late summer of 1932 and did so much damage to well equipment that it was obliged to change to the use of the more expensive inhibited acid in order to continue in business.

3. Defendant, Halliburton Company, used raw acid in the first two or three wells it acidized in the early months of 1935 and thereafter added an inhibitor to its acid until after the Grebe-Sanford patent was sustained by the Tenth Circuit Court of Appeals. Instead of then changing to the use of raw acid, it discontinued entirely its acidizing business for many months and until its experts devised the process which both the lower court and this court have held to infringe.

Against this array of undisputed evidence that it is not commercially practicable to carry on the business of acidizing oil wells with uninhibited acid, this court accepts the uncorroborated statement of a biased witness (Pitzer) that his company has successfully acidized 15,000 oil wells with uninhibited acid, and that in spite of undisputed testimony that Chemical Process Company places rolls of sheet lead in its acid tanks and that the inhibitors which defendant utilizes in its present infringing process (copper and lead chlorides) would inevitably result from the contact of the raw acid with such lead sheets.

III. The New Evidence Relating to the Gypsy Prior Use

This new evidence consists of a deposition of Dr. Wescott of the Mellon Institute, who recommended the treatment in question, and a second deposition of Dr. Knappen of the Gypsy Oil Company, whose deposition in the *Williams* case was stipulated into this record. Neither of these witnesses professes to have any first-hand information on the question here involved, *viz.*, whether the trial of the Wescott suggestion by Gypsy Oil Company constituted nothing more "than an unsuccessful and abandoned experiment," as found by the Tenth Circuit Court of Appeals, or was "completely established and its utility dem-

onstrated over a sufficient period to constitute a prior use," as found by this court.

Both these witnesses testified that they had not been present at any of the treatments on which appellee relies to establish this prior use, and both testified that their information came from the official reports and correspondence, which are present in the same form and to the same extent in both records. (R. 1082, 1087, 1102, 1111, 1113.)

It follows that there is no evidence in this record with respect to the actual treatments and the results thereof that was not present in the *Williams* record. This applies not only to the treatment to the William Berryhill Well No. 8 on November 18, 1928 (the only one of these treatments referred to in the official reports and correspondence), but it also applies to the treatments to Thomas Gilcrease Well No. 22 on September 4, 1929, and to William Berryhill Well No. 11 on September 11, 1929. Kiser is the only witness who claims to have been present at either of these later treatments, and his testimony is identically the same in both records, having been taken in the *Williams* case and stipulated into this record.

Moreover, Knappen's testimony must be considered to be the same in both records by virtue of his statement that if his testimony in this record differs from his testimony in the *Williams* record, the earlier evidence should be taken as true because the facts were then more freshly in his mind. Furthermore, Wescott's testimony adds absolutely nothing to this record, as he testified that he did not see any of these wells treated and gained all his knowledge of such treatments from the written records thereof, which are the same in this case as they were in the *Williams* case. (R. 1091, 1111.)

Accordingly, there is presented this situation: On identically the same record insofar as the actual treatments and the results thereof are concerned the court in the *Williams* case found that the Wescott method was nothing more than an unsuccessful and abandoned experiment, and this court found that it was used on the William Berryhill Well No. 8 "with complete success, and similar successful treatments of other wells followed into 1931."

On November 20, 1928, eight days after the treatment to William Berryhill Well No. 8, Dr. Knappen wrote to Dr. Foote of Mellon Institute (R. 1682):

> "The first *experiment* with the acid has been run at Glenpool with *unsatisfactory* results. * * * The acid apparently destroyed much gyp but the pump was choked with sand and it has been necessary to pull the pump several times in order to get the well to pumping normally. * * *" (R. 1683. Emphasis ours.)

The only evidence of additional treatments is the uncorroborated testimony of the witness Kiser, whose testimony is the same in both records. But even if Kiser's testimony be accepted at its full face value it does not support the above quoted statement in the opinion. The only two uses of the Wescott method to which he testified were in September, 1929. (Finding 67, R. 1488.) There is no proof of any other trial of this method, but there is undisputed proof of trials by Gypsy Oil Company of various other methods of removing gyp in the Glenpool during the period 1929 to 1932, clearly showing that they did not consider the Wescott method to be a solution of their gyp troubles.

On August 5, 1929, they treated William Berryhill No. 26 with a commercial gyp solvent. (R. 1687.)

In July, 1931, they tried the so-called trickling treatment in J. Anderson Well No. 3. (R. 1690.)

On April 12, 1932, they tried removing gyp from T. Gilcrease Well No. 21 by the use of a mechanical scraper, and two days later an engineering report recommended the use of such a scraper in J. Anderson Well No. 3. (R. 1693, 1695.)

And in May, 1932, they were looking for some kind of a gyp treating material "that would not be destroyed by reaction with the scale before reaching the bottom," as was the case when hydrochloric acid was used. (R. 1697-8.)

This record, we submit, falls far short of establishing "complete success" for the Wescott method, even if the treatments testified to by Kiser as having been made in September, 1929, be accepted as proven and as having been successful. But Kiser's uncorroborated testimony cannot be taken at its face value.

The latest statement by the Supreme Court on this subject was in *Smith vs. Hall*, 301 U. S. 216, 222:

> "This oral testimony, if taken at its face value, would show that the Smith method was used in the Brooklyn incubator with eggs in staged incubation. But without corroboration, it is insufficient to establish prior use. *The Barbed Wire Patent*, 143 U. S. 275, 284; *Deering vs. Winona Harvester Works*, 155 U. S. 286, 300; *Eibel Process Co. vs. Minnesota & Ontario Paper Co.*, 261 U. S. 45, 60. * * *"

Nor does the testimony of Dr. Wescott "that the use of inhibitors to protect metal from hydrochloric acid was well understood at the time" add anything to the record before the court in the Tenth Circuit. In a footnote on page 496 of the opinion in the *Williams* case the court refers to a number of patents which fully set forth the use of inhibitors in acid to protect metal from attack thereby, and the opinion, on the same page, states that the use of inhibited acid was "long known in the steel industry."

IV. The Conclusion That What Grebe and Sanford Accomplished Involved Nothing More Than the Ordinary Skill of the Calling and Did Not Involve Patentable Invention

We respectfully submit that this conclusion is contrary to the evidence and substitutes the intuition of the court as to what should have been obvious to those skilled in the art for the actual experience of those engaged in the production of oil and interested in increasing the output of their wells. The facts may be briefly summarized as follows:

1. In 1895-6 the oil industry learned through the issuance of the Frasch patent and the wide publicity given the Frasch experiments that hydrochloric acid introduced into the producing formation of limestone wells would dissolve the limestone, enlarge the pores or channels through which the oil flows to the well, and increase the production.

2. For more than a third of a century it had been common knowledge that the corrosive action of hydrochloric acid on iron and steel can be prevented or reduced by adding to the acid small amounts of substances known as inhibitors.

3. The number of limestone oil fields in this country had gradually increased to over 400 at the time the Grebe-Sanford invention was made.

4. There was a threatened shortage of oil during the greater part of the period between Frasch and Grebe-Sanford.

5. The prices of crude oil were nigh during the greater part of the period between Frasch and Grebe-Sanford.

6. The Grebe-Sanford invention was made during a period of low prices for oil, yet it went into immediate successful and extensive use.

7. Imitators and infringers sprang up almost immediately after the introduction of the Grebe-Sanford process, some of them (Oil Makers and Halliburton) at first attempting the use of raw acid and then changing to inhibited acid.

8. When the Grebe-Sanford patent was sustained, appellee discontinued its acidizing business entirely because it was no longer free to add an inhibitor to its acid, and did not resume its acidizing business until after its experts had devised its present infringing process.

9. The chemists, geologists, oil engineers and experts of Gypsy Oil Company, all interested in increasing the production of oil by their employer, learned through the Wescott report and the reports on the treatment of William Anderson Well No. 8 by the Wescott process in November, 1928, that inhibited hydrochloric acid could be safely used in the well tubing and that it would dissolve oil soaked gyp (calcareous deposits), yet it did not occur to any of them (all skilled in the art) to apply that information to the treatment of Gypsy Company's limestone wells with inhibited hydrochloric acid to increase their production.

10. Gypsy Company's failure to apply the Wescott process to the treatment of its limestone wells to increase production can be explained only on the theory that the Wescott process did not anticipate Grebe-Sanford (as found by the Tenth Circuit Court of Appeals, contrary to the conclusion reached by this court); nor can their failure to so apply Wescott be explained on the theory of lack of interest, low price of oil or high cost of acid, because the Gypsy Company was one of the first large oil companies to employ Dow's licensee, Dowell Incorporated, to acidize its limestone wells, at an expense of $250.00 or more per well.

CONCLUSION

We respectfully submit that the court erroneously concluded that the new evidence here requires or justifies a different conclusion from that reached by the Tenth Circuit Court of Appeals (1) as to the effect of Frasch on the validity of the patent in suit, (2) as to the commercial success of treating oil wells with raw hydrochloric acid, (3) as to the effect of the proofs in support of the alleged Gypsy prior use, (4) as to the effect of the Gypsy prior use (even if established) on the validity of the patent in suit, and, finally, (5) as to the validity of the Grebe-Sanford patent.

We respectfully urge that this petition be granted and that we be afforded an opportunity to reargue this case.

THE DOW CHEMICAL COMPANY,
Midland, Michigan,

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RUSSELL WILES,
Board of Trade Bldg.,
Chicago, Illinois,

DONALD L. CONNER,
The Dow Chemical Company,
Midland, Michigan,
Of Counsel for Appellant.

I hereby certify that in my opinion this petition is well founded in fact and law, and that it is not interposed for purposes of delay.

WILBER OWEN,
Of Counsel for Appellant.

ORDER DENYING PETITION FOR REHEARING

(Entered January 31, 1944)

The petition for rehearing is denied.

UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SIXTH CIRCUIT

I, J. W. MENZIES, Clerk of the United States Circuit Court of Appeals for the Sixth Circuit, do hereby certify that the foregoing is a true and correct copy of Record and Proceedings in the case of *The Dow Chemical Company* v. *Halliburton Oil Well Cementing Company*, No. 9392, as the same remains upon the files and records of said United States Circuit Court of Appeals for the Sixth Circuit, and of the whole thereof.

IN TESTIMONY WHEREOF, I have hereunto subscribed my name and affixed the seal of said Court at the City of Cincinnati, Ohio, this 27th day of March, A. D. 1944.

J. W. MENZIES,
Clerk of the United States Circuit Court of Appeals for the Sixth Circuit.

(SEAL)

SUPREME COURT OF THE UNITED STATES, OCTOBER TERM, 1944

No. 50

ORDER ALLOWING CERTIORARI—Filed May 15, 1944

The petition herein for a writ of certiorari to the United States Circuit Court of Appeals for the Sixth Circuit is granted.

And it is further ordered that the duly certified copy of the transcript of the proceedings below which accompanied the petition shall be treated as though filed in response to such writ.

SUPREME COURT OF THE UNITED STATES, OCTOBER TERM, 1944

No. 61

ORDER ALLOWING CERTIORARI—Filed May 15, 1944

The petition herein for a writ of certiorari to the United States Circuit Court of Appeals for the Sixth Circuit is granted.

And it is further ordered that the duly certified copy of the transcript of the proceedings below which accompanied the petition shall be treated as though filed in response to such writ.

FILE COPY

Office - Supreme Court, U. S.
APR 6 1944
CHARLES ELMORE CROPLEY
CLERK

IN THE

Supreme Court of the United States

OCTOBER TERM, 1943.

No. [redacted] 50

THE DOW CHEMICAL COMPANY, A CORPORATION,
Petitioner,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY, A CORPORATION,
Respondent.

PETITION FOR WRIT OF CERTIORARI.

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CALVIN A. CAMPBELL,
DON L. CONNER,
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Attorneys for Petitioner.

April 4, 1944.

THE QUINTHORP-WARREN PRINTING COMPANY, 310 WEST JACKSON, CHICAGO

IN THE

Supreme Court of the United States

OCTOBER TERM, 1943.

No. .....

THE DOW CHEMICAL COMPANY, A CORPORATION,
Petitioner,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY, A CORPORATION,
Respondent.

PETITION FOR WRIT OF CERTIORARI.

To the Honorable the Chief Justice and Associate Justices of the Supreme Court of the United States:

Your petitioner, The Dow Chemical Company, prays that a writ of certiorari should issue to review the decree of the Circuit Court of Appeals for the Sixth Circuit entered December 17th, 1943 (R. 2051), petition for rehearing denied January 31, 1944 (R. 2077).

A certified transcript of the record in the case, including the proceedings in said Circuit Court of Appeals is furnished herewith in compliance with Rule 38 of the Rules of this Court.

Summary Statement of the Matter Involved.

This is a suit brought by petitioner against respondent for infringement of petitioner's Grebe and Sanford Patent No. 1,877,504 covering a method of treatment of deep wells to increase their production.

In the Trial Court several other patents were involved and were disposed of by parts of the decree from which no appeal was taken, so that this Grebe and Sanford patent was the only one in issue in the Circuit Court of Appeals. It held the patent invalid.

In the Trial Court (District Court for the Eastern District of Michigan) and in the Circuit Court of Appeals the question of infringement was vigorously contested, and a large part of the record relates to that issue. After a careful review of this voluminous evidence both Courts concurred in finding that the patent was infringed if valid, and under numerous precedents that factual matter is not open to further review here.

On the question of validity there is a direct conflict of determination between the Circuit Court of Appeals for the Sixth Circuit in this case and the Circuit Court of Appeals for the Tenth Circuit in the case of *Dow Chemical Company* v. *Williams Bros. Well Treating Corporation*, 81 Fed. 2d 495, in which case the same patent was held valid. (Certiorari denied, 298 U. S. 690.)

Jurisdiction.

1. This is a suit arising under the Patent Laws of the United States, Judicial Code, Sec. 24 (7) (28 U. S. C. 41 (7)).

2. The jurisdiction of this Court is invoked under Section 240 (a) of the Judicial Code, as amended by Act of February 13, 1925 (28 U. S. C., Sec. 347).

3. The date of the decree which the petitioner seeks to have reviewed is December 17, 1943. Petition for rehearing was denied January 31, 1944.

Questions Presented.

The principal and we believe the sole question presented is the validity of the Grebe and Sanford Patent No. 1,877,504. The concurrent findings of fact on infringement render it unnecessary for this Court to reconsider that issue.

Reasons for Granting the Writ.

The discretionary power of this Court to grant a writ of certiorari is invoked upon the ground of the direct disagreement between the Circuit Court of Appeals for the Sixth Circuit (R. 2052) and the Circuit Court of Appeals for the Tenth Circuit (81 Fed. 2d 495) as to the validity of the Grebe and Sanford patent.

In accordance with the thoroughly established practice of this Court, such a conflict between the decisions of two Circuit Courts of Appeals, particularly when coupled with the unusually great economic importance of the invention involved, constitute special and important reasons for the grant of the writ, as provided in Rule 38, 5-b of this Court.

As in almost all cases where a patent is twice litigated, there is additional evidence here, and as usual its importance is stressed in the opinion of the Court of Appeals for the Sixth Circuit. The additional evidence in the instant case is of no greater weight, however, than has been the new evidence presented in numerous cases in which this Court has issued the writ.

There is a fundamental difference between the two Courts of Appeals in their respective legal views as to the patent in suit. If the legal position taken by the Court of Appeals for the Tenth Circuit be endorsed then the new evidence either strengthens petitioner's case or it is ineffective to change the conclusion of that Court.

Not only is further litigation under the patent possible in the Tenth Circuit, but the invention in dispute is being constantly and widely employed in oil and gas fields located in other circuits, notably the Fifth and Seventh Circuits, where the patent has not been litigated, and the legal residence of many of the users undoubtedly can produce litigation in several additional circuits if the issue of validity be left open to further dispute.

WHEREFORE, it is respectfully submitted that this petition for a Writ of Certiorari to the Circuit Court of Appeals for the Sixth Circuit should be granted.

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BRIEF IN SUPPORT OF PETITION FOR WRIT OF CERTIORARI.

Opinions of the Courts Below.

The trial court rendered no formal opinion. The views of the court were expressed in connection with the disposition of findings of fact presented by the respective parties and appear in Volume III of the Record at pages 1435 to 1477.

The opinion of the Circuit Court of Appeals for the Sixth Circuit was filed December 17, 1943. It is reported in 139 Fed. (2d) 473 and in 60 U. S. P. Q. 90, and it appears in the record at page 2052, *et seq.*

Jurisdiction.

The facts supporting the jurisdiction of this Court are set forth in the petition, *supra*, page 2.

Cases believed to sustain jurisdiction are—

Diamond Rubber Co. v. *Consolidated Tire Co.*, (1911) 220 U. S. 428, 436, 437.

Permutit Co. v. *Graver Corporation*, 284 U. S. (1931) 52.

Cuno Engineering Corp. v. *Automatic Devices Corp.*, (1941) 314 U. S. 84.

Automatic Devices Corp. v. *Sinko Tool & Manufacturing Co.*, (1941) 314 U. S. 94.

The Goodyear Tire & Rubber Co. v. *Ray-O-Vac Co.*, (1944) decided February 28, 1944, not yet reported.

Statement of the Case.

The patent covers the first successful and practicable method of treating oil and gas wells with acid for the purpose of increasing their production. The process, commonly known as acidizing, was first used in an oil field near Midland, Michigan, home of The Dow Chemical Company, in the Spring of 1932, a few months before the patent was applied for. Its success in increasing the production of crude oil was so remarkable that an urgent and unsolicited demand for similar treatments soon arose throughout Michigan and other states where oil is produced from limestone formations, with the result that by the Fall of 1932 the business had grown to such proportions that petitioner found it necessary to organize a separate company (Dowell, Inc.) with its own officers and personnel to properly look after this rapidly growing business.

Increases of several hundred per cent have been common as a result of the use of the Grebe and Sanford process in both new and old oil and gas wells.

Hundreds of millions of barrels of crude oil and billions of cubic feet of gas already have been recovered as a direct result of the use of this process, the urgent need for which had existed ever since crude oil was first produced from limestone formations, nearly half a century before the date of the Grebe-Sanford invention.

Argument.

Direct disagreement as to the validity of a patent between two Circuit Courts of Appeals has invariably led to a review by this Court.

In almost every case where a patent is litigated a second time after adjudication in one circuit, the party occupying the losing position in the prior litigation attempts to augment the proofs in the first case. If the presence of new evidence justified denial of the writ, practically no patent case would be reviewed by certiorari. A few well-known examples will adequately demonstrate this point.

In *Diamond Rubber Company* v. *Consolidated Rubber Tire Company*, 220 U. S. 428, plaintiff, who had previously lost in the Sixth Circuit, produced a vast amount of new evidence on a feature of operation of the tire concerning which the first record had little, if any, factual evidence.

In *Permutit Company* v. *Graver Corporation*, 284 U. S. 52, where a decree of invalidity was affirmed, there was a great deal of new evidence before the Courts in the Seventh Circuit which was not before the courts which had previously sustained the patent.

And in companion cases, *Cuno Engineering Corporation* v. *Automatic Devices Corporation*, 314 U. S. 84, and *Automatic Devices Corporation* v. *Sinko Tool and Manufacturing Company*, 314 U. S. 94, neither defendant included all of the prior art upon which the other relied.

The fact that additional evidence appears here, therefore, under the precedents does not justify a denial of the writ.

There is a fundamental difference of legal opinion between the two Courts which have passed upon the patent in suit. The Court of Appeals for the Tenth Circuit treated the invention as one which had greatly increased the re-

covery of oil and gas from underground deposits and one which had enormously added to the national wealth. This brought the invention within the group which has satisfied a long-felt want and, that Court, recognizing the advancement made by the patentees, therefore held it to be inventive.

The new evidence stressed by the Court of Appeals for the Sixth Circuit falls into a small number of classes.

First, the present record contains evidence of actual tests of a prior art process for acidizing oil wells to increase their production, the patent for which[1] was fully considered by the Tenth Circuit Court of Appeals and held insufficient to sustain the defense of lack of invention. The new evidence here relating to this prior process, the more controlling and conclusively proven portion of which was introduced by petitioner, shows that the process was thoroughly tested by eminent oil men in 1895-7 and that although it increased oil production in several wells it was completely abandoned and never again used. More than thirty years then elapsed before Grebe and Sanford made their invention, during which period there was grave fear of early oil exhaustion and the number of wells producing from limestone formations increased tremendously. Had these facts been presented to the Court of Appeals for the Tenth Circuit they would have strengthened plaintiff's case instead of weakening it. The failure of that early process to meet with commercial success and its abandonment by the very eminent men who owned the patent after adequate tests and considerable publicity as to their results strongly supports the conclusion of the Tenth Circuit Court of Appeals that the process was commercially impracticable. Knowledge of these facts naturally would have driven oil men away from a new process of the same general type rather than lead them to an attempt to resurrect an old abandoned process. For these reasons we believe that this

1. Frasch 556,669 March 17, 1896, R. 1935.

part of the new evidence is distinctly favorable to petitioner's case on the Tenth Circuit view of the law.

Secondly, the Sixth Circuit and the Tenth Circuit take diametrically opposite positions on the effect to be given certain operations of the Gypsy Oil Company. As to this matter, the evidence in the two cases is identical except for an additional deposition given by a witness who had testified in the Tenth Circuit case and who produced no additional records and testified that his memory was better when he gave his first deposition, and the deposition of an expert who testified from records in evidence in the Tenth Circuit case. Neither could nor did add anything factually new. The additional evidence on this subject is immaterial and would not have changed the view of the Court of Appeals for the Tenth Circuit in the slightest degree.

The third group of new evidence has to do with operations of a kind not disclosed by the prior art, but practiced by others after the Grebe and Sanford invention became well-known in an effort to get some of its benefits while avoiding the claims of the patent. This group of evidence is not prior art and is irrelevant. Had it been offered in the Tenth Circuit it could not have altered the conclusion that Grebe and Sanford completely and satisfactorily met an ancient and enormously important need.

The advance in the art described in the patent in suit is of overwhelming industrial importance. Few advances have added so much to our national wealth and our national resources. In this country the process is used almost universally in the oil and gas fields, the wells of which produce from limestone or dolomite formations. The process is responsible for a large part of the oil production coming from one-quarter to one-third of our producing wells.

H. C. Miller, Senior Petroleum Engineer with the United States Bureau of Mines at San Francisco, testified before

a Sub-Committee of the Committee on Interstate and Foreign Commerce of the House of Representatives at a hearing held in November, 1939, and that testimony is stipulated here. (R. 235 *et seq.*) His testimony was in part as follows:

> "Almost every well drilled into a limestone formation is treated with hydrochloric acid at some time during its producing life. • • •
>
> "Acid treating has had a far reaching effect on the petroleum industry in that it has effected a complete change of attitude toward limestone production. • • •
>
> "Acid treatment of wells to increase the productivity and ultimate recovery of oil and gas is now generally accepted as standard production practice in Michigan, Kansas, Ohio, Illinois, Kentucky, Oklahoma, Texas and Louisiana, where oil is found in reservoirs of calcareous and dolomitic rock. • • •
>
> "The practice of acidizing wells has grown phenomenally in the past five years, and at present about 10,000 wells are treated annually, requiring approximately 25,000,000 gallons of acid. • • •"

Aside from the attempt, previously referred to, to commercialize the Frasch process in the Lima, Ohio, field during the period 1895 to 1897, the record fails to show a single instance where an oil well was treated with acid in an attempt to increase its production until the introduction of the Grebe-Sanford process in the Spring of 1932.

Few patents have ever been litigated whose subject-matter has created so much real wealth. Whether that subject-matter is or is not inventive must be determined mainly on legal grounds and as to those the two Courts of Appeals differ fundamentally.

Defendant-respondent adopted an ingenious method of avoiding an appearance of infringement and the record in the Trial Court and in the Circuit Court of Appeals was necessarily devoted in large measure to factual evidence that defendant actually employed the process of the patent

in suit. This was an entirely new issue not involved in the Tenth Circuit case where infringement was conceded.

On the new issue of infringement the District Court and the Court of Appeals for the Sixth Circuit agree entirely that defendant-respondent follows the teachings of the patent in suit and uses the claimed invention, if it be an invention at all. Under numerous precedents as to concurrent findings in the lower courts, it is not believed that this Court need review that point. The sole question which is open is whether or not the patent in suit displays invention or mechanical skill.

The instant case is one of a comparatively small group where invention must depend upon the long-felt want rule. It is a curious coincidence that although these cases are comparatively rare, this Court has but recently had before it another quite similar case, *Goodyear Tire & Rubber Company, et al* v. *Ray-O-Vac Company,* decided February 28, 1944. Petitioner's position which was accepted by the Tenth Circuit Court of Appeals is that the Grebe and Sanford Patent is fairly within this rule. The determination of that question should settle this controversy.

Respectfully submitted,

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Attorneys for Petitioner.

April 4, 1944.

IN THE

Supreme Court of the United States

October Term, 1943.

No. 855 [redacted] 61

THE DOW CHEMICAL COMPANY, a corporation,

Petitioner,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY, a corporation,

Respondent.

CROSS PETITION AND BRIEF FOR RESPONDENT.

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IN THE

Supreme Court of the United States

October Term, 1943.

No. 855

THE DOW CHEMICAL COMPANY, a corporation,

Petitioner,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY, a corporation,

Respondent.

CROSS PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SIXTH CIRCUIT.

To the Honorable the Chief Justice and to the Associate Justices of the Supreme Court of the United States:

Respondent, Halliburton Oil Well Cementing Company, respectfully prays that a writ of certiorari issue to review the decree of the United States Circuit Court of Appeals for the Sixth Circuit in the case of *The Dow Chemical Company v. Halliburton Oil Well Cementing Company*, No. 9392, by which decree respondent was held to have infringed United States patent No. 1,877,504 if said patent be valid.

The Dow Chemical Company has filed a petition with this Honorable Court praying that a writ of certiorari issue to review the said decree of the Circuit Court of Appeals for the Sixth Circuit in so far as such decree holds that the said United States patent No. 1,877,504 is invalid. This petition of respondent is in the nature of a cross petition for certiorari to enable respondent to be heard upon the issue of infringement of said Letters Patent No. 1,877,504 in the event a writ of certiorari issue upon the petition of The Dow Chemical Company.

A certified transcript of the record in this case has been filed in this Court by petitioner, The Dow Chemical Company. The decree [Vol. IV – 2051] and the opinion [Vol. IV – 2052] of the Circuit Court of Appeals were filed December 17, 1943, and a petition for rehearing was denied on January 31, 1944 [Vol. IV – 2077].

Jurisdiction.

For the purpose of this cross petition respondent adopts the statements as to jurisdiction appearing upon page 2 of the petition filed by The Dow Chemical Company.

Statement and Reasons Relied Upon for Allowance of the Cross Writ.

The sole question presented by the petition filed by The Dow Chemical Company to review the decree below is confined to the validity of the patent in issue, and The Dow Chemical Company in presenting its petition seeks to forestall any review by this Court of the holding be-

low that respondent has infringed the patent in suit if that patent be valid.

As more fully stated in the accompanying brief, the questions of validity and infringement of the patent in suit are dependent and so interwoven that a denial to respondent of a review of the question of infringement would be unjust if the petition of The Dow Chemical Company be granted and a review be had of the question of validity.

The reason assigned by The Dow Chemical Company why this Court should not review the question of infringement is that there are concurrent findings and conclusions by the Circuit Court of Appeals and the District Court against respondent on this issue. However, there are also concurrent findings and conclusions in this case in the Circuit and District Courts against The Dow Chemical Company as to the invalidity of the Letters Patent in issue. The existence of concurrent findings and conclusions in this case in the District and Circuit Courts should have the same effect before this Court upon the issues of validity and infringement. Either such concurrent findings and conclusions should preclude a review of both the issues of validity and infringement or they should preclude a review of neither.

Question Presented.

Respondent by this cross petition, in the event the petition of The Dow Chemical Company be granted, seeks a review of the holding below that respondent has infringed Letters Patent No. 1,877,504 if said Letters Patent are valid.

Wherefore, respondent, Halliburton Oil Well Cementing Company, prays that this petition be granted and that the aforesaid question be determined by this Court in the event a writ of certiorari issue to the Circuit Court of Appeals for the Sixth Circuit granting a review of the decree of that Court in this case.

Dated at Los Angeles, California, April 14, 1944.

HALLIBURTON OIL WELL CEMENTING COMPANY,

By LEONARD S. LYON,

Its Attorney.

IN THE

Supreme Court of the United States

October Term, 1943

No. 855

THE DOW CHEMICAL COMPANY, a corporation,

Petitioner,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY, a corporation,

Respondent.

BRIEF FOR RESPONDENT.

I.

Opinions of the Courts Below.

The opinion of the Circuit Court of Appeals for the Sixth Circuit in this case is reported in 139 F. 2d 473 and appears in the printed record at pp. 2052 *et seq.*, No written opinion was filed by the District Court, but the District Court expressed its views upon the issues during the settlement of the findings of fact and conclusions of law as set forth in the printed record at pp. 1435-77 and by the entry of findings of fact and conclusions of law which are reproduced in the printed record at pp. 1478-92.

II.

Jurisdiction.

Although in the absence of a cross petition for certiorari respondent may be able to urge any point appearing in the record which will support the decree below, a cross petition to assure the right to raise such a point is in order.

Honolulu Oil Corporation v. Halliburton, 306 U. S. 550, 83 L. Ed. 980.

Respondent is presenting this cross petition to avoid any question of its right to be heard on the issue of infringement in the event the petition of The Dow Chemical Company for a writ of certiorari in this case be granted.

III.

Statement of the Case.

Under this title The Dow Chemical Company in its brief completely misrepresents the nature and character of patent No. 1,877,504 involved in this case. This patent is not to be viewed as covering the first successful or any process for treating oil and gas wells with acid. As found by the courts below the use of hydrochloric acid for treating oil and gas wells was fully disclosed as early as 1896 in the prior Frasch patent No. 556,669. All that the patent in suit purports to add to such a process is the addition of a small amount of a chemical inhibitor to protect the well pipe from the hydrochloric acid. As

said in the opinion of the Circuit Court of Appeals below:

> "The single question is whether the conception of adding a corrosion inhibitor to hydrochloric acid for use in acidizing wells in order to reduce corrosion requires anything more than the ordinary skill of the calling or involves any patentable invention."

The patent in suit (Vol. IV, 1501-1503) discloses nothing more than adding a small amount of a substance capable of inhibiting attack of the acid upon the metal surfaces with which it comes in contact [p. 1, lines 75-80], and suggests for that purpose the addition of "a small amount, *e. g.*, 1 to 5 per cent, of an arsenic compound" [p. 2, lines 73-4]. As found by the Court of Appeals the use of inhibitors to protect steel from hydrochloric acid was well known in the prior art dating from as early as 1845, and including the use of arsenic compounds.

Respondent is not charged with infringement of the patent in suit because it adds to the hydrochloric acid employed by respondent in acidizing a well any of the inhibitors named in the patent in suit or any other inhibitor of the type or in the quantity called for by the patent in suit. The hydrochloric acid employed by respondent in acidizing oil wells is transported from storage tanks to the wells to be acidized in steel transportation tanks. Respondent adds to the hydrochloric acid no corrosion inhibitor or agent capable of inhibiting the action of the acid upon steel unless the formation of metallic chlorides (lead and copper) in the transportation tanks be deemed

such an addition [Finding No. 87, Vol. III – 1491]. Respondent bonds a lead plate within the steel transportation tanks, thereby producing a battery action causing a flow of electric current from the lead plate through the acid to the steel wall of the transportation tank, and in this way protects the steel of the transportation tanks [Finding No. 88, Vol. III – 1491]. This battery action in respondent's transportation tanks results in the formation of minute amounts of copper, lead and iron chlorides incidental to the method used by respondent for protecting its transportation tanks [Finding No. 90, Vol. III – 1491]. The presence of such minute quantities of copper, lead and iron chlorides in the acid somewhat reduces the corrosive action of the acid, but even then the acid is many times more corrosive than that resulting from following the directions of the patent in suit [Finding No. 91, Vol. III – 1491]. If respondent omitted the lead plate in its transportation tanks, the acid, in lieu of attacking the lead plate, would attack the steel walls of the tanks and produce minute amounts of chlorides which would have the very effect complained of. Indeed it was shown that all commercial hydrochloric acid necessarily contains such chlorides because of the action of hydrochloric acid upon the metal equipment in which it is made and upon the metal equipment in which it is stored or transported. At the trial counsel for The Dow Chemical Company conceded that within their concept of the scope of the patent in suit hydrochloric acid could not be transported out to an oil field in a steel tank without infringing the patent.

In presenting this petition respondent should not be understood as subscribing to the grant of the petition of The Dow Chemical Company. While the patent in suit was held valid by the Circuit Court of Appeals for the Tenth Circuit in 1936 in *Dow Chemical Co. v. Williams Bros. Well Treating Corp.*, 81 F. (2d) 495, reversing the District Court for the Northern District of Oklahoma which had adjudged the patent invalid, the court in that case did not have before it a large part of the evidence in the record in this case. In its brief before this Court petitioner has the temerity to represent that had this evidence been presented to the Court of Appeals for the Tenth Circuit, it would have "strengthened plaintiff's case instead of weakening it." Nothing could be further from the truth. The findings of fact entered by Judge Tuttle in the court below in this case include the following:

> "But the record before this court here contains a large amount of new evidence not before the courts in that case, and this new evidence is of such a character that it may fairly be concluded that the Circuit Court of Appeals for the 10th Circuit would have reached a different conclusion had it been advised of its existence." [Vol. III – 1485.]

Since the decree below holding the patent in suit invalid is based on concurrent findings of fact and conclusions of law, we cannot see what petitioner can hope to accomplish by a hearing in this Court.

> *Goodyear Tire & Rubber Co. v. Ray-O-Vac Co.*, decided Feb. 28, 1944, 88 L. ed. 475.

IV.

ARGUMENT.

The purpose of The Dow Chemical Company in seeking to avoid a consideration of the issue of infringement in this case at the time that this Court would be considering the issue of validity of the patent in suit is manifest. The issues of validity and infringement of a patent, both involving as they do an interpretation of the scope of the patent, should not ordinarily be separately adjudicated. Where the charge of infringement involves a stretching of the scope of the patent, the validity of the patent should be determined with the same broad consideration. A patent owner should not be permitted to support the validity of his patent upon narrow grounds and at the same time urge infringement of the patent upon broad grounds. Yet that is what the patent owner in this case hopes to do and is why it seeks to forestall any consideration of the issue of infringement by this Court. The situation is so apparent that we do not feel the point requires further argument.

We will not attempt to urge upon this petition the merits of respondent's defense of non-infringement. It is sufficient to say that the defense is substantial, as is apparent from our previous statement. It is true that both the District Judge and the Judges of the Court of Appeals in this case have reached conclusions on this issue against respondent. However, in view of the fact that both the District Court and the Circuit Court were in the process of holding the patent in suit invalid, the issue of infringement received scant attention in both courts. This is not unusual in patent cases, and the fact that it is not unusual demonstrates the necessity for an appellate

court to consider the scope asserted for a patent on the issue of infringement at the same time that the appellate court is determining the validity of the patent.

The issue of infringement to be determined before this court if respondent's cross petition be granted would be a legal issue. We do not challenge the findings of the District Court as to how respondent protects its transportation tanks or the fact that in so doing the hydrochloric acid picks up minute amounts of chlorides which to some extent reduce the corrosiveness of the acid during its progress down the well. We do, however, contend that this practice should not be held to constitute an infringement of the patent in suit. We would expect to show to this Court that the minute amounts of chlorides picked up by the hydrochloric acid while in respondent's transportation tanks do not correspond in nature or amount with the inhibitors called for by the patent in suit; that such chlorides are embraced within the metallic chlorides which were disclaimed during the prosecution of the patent in suit; and that to sustain the patent in suit and the charge of infringement in this case would be to give petitioner a monopoly covering any and every means of rendering hydrochloric acid less corrosive during its use for acidizing a well.

Accordingly it is respectfully submitted that if this Court should undertake to review the validity of the patent in suit, it should also review the issue of infringement in this case.

Respectfully submitted.

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IN THE

Supreme Court of the United States

OCTOBER TERM, 1943.

No. [redacted] 61

THE DOW CHEMICAL COMPANY, A CORPORATION,
Petitioner,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY,
A CORPORATION,
Respondent.

PETITIONER'S REPLY TO RESPONDENT'S CROSS PETITION.

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April 25, 1944.

THE BLAKEMORE-WARREN PRINTING COMPANY, 310 WEST JACKSON, CHICAGO

IN THE

Supreme Court of the United States

OCTOBER TERM, 1943.

No. 895

THE DOW CHEMICAL COMPANY, A CORPORATION,
Petitioner,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY,
A CORPORATION,
Respondent.

PETITIONER'S REPLY TO RESPONDENT'S CROSS PETITION.

While this Court has undoubted authority to review any questions presented by the record, there is ample precedent for limiting the questions to be considered on a Writ of Certiorari. For example, in *Automatic Devices Corporation* v. *Sinko Tool & Manufacturing Co.*, 314 U. S. 94, and *Automatic Devices Corp.* v. *Cuno Engineering Corp.*, 314 U. S. 84, the review was limited to the single question of validity, as to which there was a divergence of view between two Circuit Courts of Appeals. The particular infringement issue, upon which only the Court of Appeals of the Seventh Circuit had passed, was excluded.

In the suit on the Grebe and Sanford patent here in issue, brought in the Tenth Circuit where the patent was held valid, defendant precisely copied the patent so no question of infringement was involved.

In the instant case, defendant somewhat varied from the procedure of the patent and so for the first time, infringement became an issue. A vast amount of testimony was

taken on that question, probably more than half of the voluminous record being devoted to that subject. Both the District Court, and the Circuit Court of Appeals, agreed in finding that defendant had appropriated any invention which might be present in the patent in suit.

According to our understanding of the practice, when two Courts of Appeals differ on the validity of a patent, this Court re-examines the facts so far as is necessary to reach a proper conclusion.[1] On the other hand, when a separate issue like infringement has arisen in only one case, and in that case the District Court and the Court of Appeals concur in their conclusions, this Court customarily does not re-examine the facts.[2]

The new issue of infringement, raised for the first time in the instant case, and decided by both Courts in our favor, involves a technical study of involved evidence. It is all boiled down in the following brief extract from the decision of the Court of Appeals:

> "The appellee's acid in its initial state has no inhibitor added to it. It is transported to the wells in steel containers on the inside of which a number of lead sheets are brazed. A battery action is thereby set up and minute quantities of ~~dissolved iron and copper~~ are deposited on the inside of the steel container, forming a protective coating. An acid solution of about fifteen per cent concentration is used by the appellee, and

1. *Thompson Spot Welder Co.* v. *Ford Motor Co.*, 265 U. S. 445, 447.
   Sanitary Refrigerator Co. v. *Winters*, 280 U. S. 30, 34.
   Concrete Appliance Co. v. *Gomery*, 269 U. S. 177, 180.

2. *Continental Paper Bag Co.* v. *Eastern Paper Bag Co.*, 210 U. S. 405.
   Pick Mfg. Co. v. *General Motors Corp.*, 299 U. S. 3.
   General Talking Pictures Corp. v. *Western Electric Co.*, 304 U. S. 175, 178.
   Alabama Power Co. v. *Ickes*, 302 U. S. 464, 477.
   Washington Securities Co. v. *United States*, 234 U. S. 76, 78.
   Just v. *Chambers*, 312 U. S. 383, 385.

when the acid is inserted in the tubing of the well, the copper, and iron dissolved therein act to reduce corrosion from forty to sixty per cent. Although no chemical action is present between the hydrochloric acid and the arsenic compounds which are used by appellant as inhibitors, as is the case in appellee's process, the District Court found, we think correctly, that appellee infringes if the patent is valid. There is no substantial difference between the results secured by the appellee and that secured by appellant, and the method used is essentially the same."

There is no difference of opinion on this point, and we respectfully submit that under its established practice, this Court should accept this much of the decision below. Certainly to do so would very greatly simplify the study of the case.

Of course there are cases where validity and scope are so inter-related that it is difficult to consider one question without considering the other. This is not such a case. Either the subject matter claimed in the Grebe and Sanford patent is invention or it is not. If it is invention on any ground, defendant, as found by both courts below, has appropriated it, and there is no need for this court to review that finding.

Respectfully submitted,

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October Term, 1944

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Respondent.

No. 61

HALLIBURTON OIL WELL CEMENTING COMPANY, A CORPORATION,
Cross-Petitioner,

vs.

THE DOW CHEMICAL COMPANY, A CORPORATION,
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BRIEF FOR PETITIONER ON THE QUESTION OF VALIDITY

OPINIONS BELOW

The opinion of the Sixth Circuit Court of Appeals in this case holding Grebe and Sanford patent No. 1,877,504[1] invalid is reported in 139 Fed. 2d 473, 60 U. S. P. Q. 90. (R. 2052.) The opinion of the Tenth Circuit Court of Appeals holding the same patent valid in an earlier case is reported in 81 Fed. 2d 495.

The views of the trial court in this case were expressed in connection with the disposition of findings of fact presented by the respective parties and appear in Volume III of the Record at pages 1435 to 1477.

(1) R. 1501.

JURISDICTION

The opinion on appeal was filed December 17, 1943, and plaintiff's petition for rehearing was denied January 31, 1944. Plaintiff's petition for *certiorari* and defendant's cross-petition were both granted May 15, 1944. (322 U. S. ....) The jurisdiction of this court is confirmed by Section 244(a) of the Judicial Code as amended February 13, 1925, 28 U. S. C. Section 347.

THE QUESTION PRESENTED

The sole question presented by the petition is whether or not the Grebe and Sanford patent involves invention. The cross-petition raises the issue of infringement, which is considered in a separate part of this brief.

STATEMENT OF THE CASE ON THE PETITION

Petitioner sued respondent in the District Court for the Eastern District of Michigan, charging infringement of the Grebe and Sanford patent.[2] Both invention and infringement were denied. The trial court held the patent invalid for want of invention and that conclusion was affirmed on appeal.

The Tenth Circuit Court of Appeals had previously held the patent valid in *Dow Chemical Company vs. Williams Brothers*, 81 Fed. 2d 495, and as will appear later there is a fundamental disagreement in the legal positions of the two courts on the question of validity on substantially the same records. What additional evidence there is here on that issue will be reviewed in connection with the subjects to which it relates.

---

[2] Other patents were involved in the trial and were disposed of by parts of the decree not appealed from. The above patent was the only one before the Circuit Court of Appeals.

The bulk of the record in pages relates to infringement. In the Tenth Circuit case infringement was not contested, and there has been no conflict of opinion on infringement by the process involved here. In this case both the trial and appeal courts held that the patent, if valid, would have been infringed by defendant's process.[3] Therefore, under numerous precedents of this court relating to concurrent findings of fact the issue of infringement is not believed to be open here, even though respondent's cross-petition for *certiorari* was granted. Nevertheless, in view of the granting of the cross-writ, infringement is separately briefed. (*Infra*, p. 62 *et seq.*)

There has been no suppression of the invention, no pooling and no suggestion of improper use of the patent. The invention has been made easily available to the entire oil producing industry through the issuance of a number of licenses on fair terms and it has been widely adopted and used.

The Patent in Suit

The patent is for a method of treating deep wells to increase their production. Upon the development and testing of the patented process, it immediately went into very widespread, indeed practically universal, use in oil and gas wells producing from limestone formations. Seldom has a new process received the tribute of such immediate and widespread acceptance. It has added enormously to our national wealth and aided greatly in the conservation of our resources. Without the increased oil production brought about by its use, our present petroleum shortage would indeed be desperate.

To understand the process one must know something about oil wells. Modern oil wells range in depth from 1200

(3) Finding 84 (R. 1490), conclusion 2 (R. 1492, 2054).

or 1500 feet to more than 10,000 feet. In each the hole is cased with a steel pipe 6 to 12 inches or more in diameter, which generally extends down to the top of the producing formation. Within this casing is a steel pump tube usually 2 to 3 inches in diameter, which extends from the top of the well to below the bottom of the casing. This tube carries a pump near its lower end, although in a free flowing well the pump is omitted until the flow falls enough to require pumping. Oil enters through a perforated section of tubing located below the pump, which is operated by a pump rod running through the tubing.[4]

In practicing the process of the patent the pump rod and valves are removed and a quantity of dilute commercial hydrochloric (muriatic) acid, to which has been added an inhibitor, is run or pumped into the regular well tubing and forced by pressure out through the perforated section of tubing and into the oil-producing formation surrounding the well hole where it enlarges the pores and forms new channels by eating away the limestone, thereby facilitating the flow of oil to the well. By virtue of the dilution of the acid it readily enters the earth formation and the resulting spent solution is easily purged from the formation when the pressure is released. The inhibitor prevents the acid from attacking and damaging such metal equipment of the well as the pump tubing, well casing, etc., but does not affect the action of the acid on the limestone.

In spending itself on the limestone the acid forms carbon dioxide gas and calcium chloride. The calcium chloride dissolves in the water of the acid solution to form the spent acid solution and the pressure is usually sufficient to hold the carbon dioxide gas in this solution.

The strength of the acid solution varies with the amount of water added to commercial hydrochloric acid,

(4) See drawing of Grebe patent 1,916,122. (R. 1506.)

which generally contains around 30% of the acid ingredient HCl. The patent states that the preferred strength of the acid is between 10% and 15% concentration, the broad range being between 5% and 20%, which is the range called for in some of the claims. Approximately 15% acid is used by petitioner and its licensees and by respondent.

The preferred corrosion inhibitor is metallic arsenic, but the patent states that other inhibitors may be used, naming several. Some of the claims limit the inhibitor to arsenic, but others are broad as regards the inhibitor.

The patent contains only process claims, of which Nos. 1, 5, 7, 8 and 9 are in suit. The Tenth Circuit Court of Appeals held the patent valid over all the art here presented. Although recognizing that the question of invention was close, it resolved the doubt in favor of the patent because an urgent need for a workable process to increase the production of petroleum from limestone wells had existed for more than a third of a century with the means adopted by Grebe and Sanford for its solution readily at hand during the entire period. The fact that no one had discovered and applied their simple solution convinced that court that it was not obvious to those skilled in the art of oil production.

Instead of proving that the solution of the problem was simpler than it was considered to be by the court in the Tenth Circuit, the additional evidence here strongly confirms the conclusion of that court that the only previous effort to increase the production of limestone wells by the use of hydrochloric acid was "cumbersome and expensive, and probably impracticable * * *."[5] Additional evidence here strongly confirms this conclusion and shows an even greater need for the Grebe-Sanford invention than appeared in the Tenth Circuit, yet the courts below disre-

(5) Frasch patent 556,669. (R. 1935.)

garded the "long felt want" rule and applied instead the dangerously unreliable rule of "retrospective simplicity."

The history of petroleum production and recent decisions of this court, as well as earlier ones, support the application of the long felt want rule to the facts presented here.

Production of Petroleum

Crude petroleum is seldom, if ever, found in large pools, but instead saturates and fills the small openings or pores in somewhat permeable sandstone and limestone rock strata. In many new wells the underground pressure is sufficient to force the oil up to the top of the casing, where it flows out by itself with no assistance. In such cases the pump tube and pump are omitted. Eventually the flow decreases, partly because of a loss of underground pressure, and pumping becomes necessary. As oil is pumped out, the underground flow to the well decreases and the yield falls off. At length the oil seeps so slowly into the well that the yield falls to a point where it no longer pays to pump the well, which must then be abandoned.

This is the history of nearly every oil well—gradually declining yield until it scarcely pays to operate it, and finally complete practical exhaustion. Obviously, crude oil prices will affect the time for abandoning any given well. With high prices it may pay to keep a well running a long time with trifling production. Obviously, too, comparatively shallow wells can profitably be pumped longer than deep wells. But the end is always the same.

The oil deposits which were first discovered and which are still the most numerous are in sandstone, but at present about one-quarter to one-third of our oil comes from limestone, and it is to the recovery of that oil that the invention in suit is directed.

It has long been known that when a well or a field containing many wells is exhausted a large part of the oil in the rock is still left unrecovered and, by ordinary means, unrecoverable. Nobody believes that more than half is recovered and common estimates on commercial recoveries run all the way from 10% to 40%. Prior to the introduction of the process of the patent in suit it was believed that the recoveries from limestone fields ran only a little more than 30%. (R. 18, 29, 30.)

The recovery of this vast amount of untouched oil always has been a matter of prime importance to the oil industry. America's first well, the Drake, went into production in 1859, and soon thereafter decreases in yields became evident.

The certain knowledge that every field, no matter how far its production may have fallen, still contains at least as much oil as has ever been taken out makes this problem of additional recovery one of the most important of all the unsolved riddles of industry.

Manifestly, the exhaustion of a well or a field is always a serious matter to the owners. It is of little moment that another field may have been discovered to maintain national production. When the owner's daily yield of oil falls off and finally vanishes it is a calamity to him and the knowledge that there is still underground two or three times as much oil as he has obtained has naturally led to numerous efforts to recover that vast remainder.

In addition to the constant pressure on individual owners to restore their own vanished production, the whole country has from time to time had such low proven oil reserves that the country has several times faced imminent exhaustion of our national oil supplies. (R. 28.) Fortunately, old fields have been extended and new fields discovered so as to push the danger of national shortage

further and further away, although the present war demand is again periling our petroleum resources.

Efforts to Solve the Problem

The efforts at solutions have been legion. As early as 1865 methods for increasing yield began to be used and patented. At first, explosives were discharged in the well hole to shatter and crack the adjacent rock. Shooting tends to make a few large cracks rather than to enlarge and open innumerable small channels. It helps production somewhat, but its effect is more or less local. Obviously, however, this cannot greatly affect oil held in tiny pores throughout the vast rock strata. Nevertheless, shooting wells has been common practice for probably eighty years. (R. 19, 1522.)

Flow also has been somewhat increased by closing the top of the well casing and producing a partial vacuum in it by pumping. However, since a perfect vacuum is only 15 pounds per square inch below atmospheric pressure and since the weight of overlying rock subjects any layer to very high pressures, the percentage by which pressure in the well can be reduced by vacuum is so small that it makes comparatively little difference. (R. 21-23.)

Efforts also have been made to increase oil recoveries by forcing either gas or water into the formation to drive the oil to producing wells. Occasionally these efforts at repressuring have been beneficial, but all too often the rock has cracks into which the fluids find their way and through which they escape without doing any good. (R. 24.) Even when successful, repressuring involves large capital expenditures for pumping machinery and auxiliary equipment and can only be applied to a group of wells or an entire pool. Furthermore, this equipment must be operated for some time before substantial results are obtained and

must be kept in operation in order to maintain production.

Also, various efforts have been made to heat the rock around a central producing well and by a combination of distillation and pressure to force the oil into that well. Still other efforts have been made to mine the oil bearing strata by driving shafts and tunnels into which the oil can seep. (R. 25-27.)

The patent art shows an even greater variety of schemes to get more oil out of the ground. (R. 45-55, 1521-30, 1533-77.) Prior to the invention in suit patents relating to treating wells to increase recovery numbered about 200. (R. 57.) Some patents recommend building a fire in the well to heat the surrounding rock and make the oil flow more freely. Others propose to heat the rock by passing electric currents through it. A number of patents outline schemes of heating the formation by introducing steam. Some patents suggest the use of benzene to dissolve paraffin deposits and permit an easier flow. Others suggest the use of gas pumped into a formation to drive the oil before it, and several patents describe forcing water into the rock to wash out the oil.

Of all these prior art methods the only ones ever to yield substantial success are shooting and repressuring, and shooting is the only one that ever went into general use in limestone fields. Now, shooting has been largely superseded in limestone fields by acidizing, which was introduced by petitioner in 1932. (R. 25, 237.)[6]

In sharp contrast with the high capital expenditure for equipment and the time and continued expense involved in repressuring operations, acidizing can be applied to individual wells at small expense and, when successful, yields

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[6] The record contains data relating to new oil wells in one Michigan field for the period 1928 to 1940, inclusive. While some new wells were "shot" up to and including 1932, the year when the Grebe-Sanford acidizing process was first used, none were shot after that year and many were acidized. During the five years beginning with 1936 every new well was acidized. (R. 168.)

an immediate flush return with no capital outlay for well equipment and no operating cost to the well owner.

The Frasch Process and Patent

In 1896 patent No. 556,669 issued to Herman Frasch, with a half interest assigned to John W. Van Dyke. (R. 1935.) Frasch was the leading industrial chemist of his day. He was closely associated with the early Standard Oil group and is generally credited with having turned Ohio oil into a useful product by inventing a process for removing the sulphur. (R. 1041.) This process not only freed the oil from its intolerable odor but made it possible to burn the kerosene produced from it in a lamp without the white deposit characteristic of sulphur on the lamp chimney. (R. 1057.) Frasch also invented the modern process of recovering sulphur from underground deposits and that invention created our American sulphur industry. For these and other achievements he was awarded the Perkin medal, the highest honor a chemist can receive.

For more than thirty years prior to the date of the Grebe-Sanford invention Van Dyke was in a position to commercialize any process for increasing the output of oil wells which promised success. He was a leading member of the old Standard Oil organization and upon the dissolution of the Standard Oil Company in 1911 became president of Atlantic Refining Company, the Pennsylvania fragment of the old company, and later became president of its producing subsidiary, Atlantic Oil Producing Company, in which positions he continued for many years. (R. 1037, 1161.)

This Frasch patent has been the principal prior art reference in both suits on the Grebe-Sanford patent. In the Tenth Circuit case, where there was no evidence of an attempt to practice the Frasch process, the court stated:

> "Frasch's method was cumbersome and expensive, and probably impracticable because of the inherent difficulty in adequately sealing off the acid at the bottom of the hole. In any event, Frasch's patent *met with no commercial success.*"(7)

In the present case respondent sought to prove that the Frasch process had been successfully commercialized about the date of the patent by offering some old correspondence under the ancient documents rule and the testimony of a few witnesses who still had a very general hearsay knowledge of the facts. Plaintiff followed with more definite proof of Frasch's actual operations by offering contemporary published articles regarding the few treatments made with the Frasch process.

This evidence shows that the Frasch process was tried under the supervision of Van Dyke on sixteen wells producing from Trenton limestone near Lima, Ohio, during 1895-97. Two producing wells were not increased at all, two dry holes were not benefited, and in only two of the other twelve wells was there a sufficient increase to justify the expense of the treatments. A careful study of the data on the fourteen producing wells shows that the process increased production *immediately* after the treatments by an average of 11½ barrels a day per well, which was insignificant compared with the cost of the treatments. How long these small increases held up does not appear.

Based on this new evidence, the lower courts in this case called the Frasch operations a commercial success, apparently because some of the treatments somewhat increased production. The Circuit Court of Appeals particularly stressed percentage figures, referring to one well

(7) All emphasis in quotations is added unless otherwise indicated.

as showing a 300% increase, whereas the flow was actually increased only from one barrel to four barrels a day.[8] This was the first well treated and was owned by the Ohio Oil Company, which discontinued the use of the process after three more of its wells were treated.[9]

Thus, whatever merit the Frasch process actually had was thoroughly known to very eminent oil men who had the ability and the opportunity to extend its use had it been considered a commercial success. Yet, the Ohio Oil Company dropped the process after four treatments and further use of it was completely, totally and finally abandoned after a dozen other scattered treatments. No effort to increase the production of wells by the introduction of any kind of acid into the producing formation was ever again attempted until the Grebe-Sanford process was successfully applied to Michigan oil wells more than a third of a century later.

The striking contrast between the Frasch failure and the brilliant and spontaneous success of the Grebe-Sanford process cannot help challenging the interest of this court, particularly in view of the conclusion reached by the lower courts that the two processes are substantially the same. Although the record does not clearly show why the Frasch process was abandoned, it does show conclusively that the process was a commercial failure. Possible contributing causes were:

[8] This reference was to the Crosley well, treated in August, 1895. (R. 1653, 1894.)

[9] One on the J. W. Taylor farm, treated prior to November 7, 1895, with an apparent increase from 5 to 35 barrels a day (R. 1657); one on the Mary Richard farm, treated prior to January 15, 1896, with an increase from 4 to 11 barrels a day (R. 1658), and one on the Thos. Cusac farm, treated prior to January 15, 1896, with no increase. (R. 1658.) Before the treatment the Taylor well was flowing at the rate of five barrels a day and after the treatment it had to be pumped, and therefore the actual results of the treatment are not known. (R. 1897, 1899.)

1. The cumbersomeness and impracticability of the manipulative steps.[10] According to Frasch's patent (R. 1936) the ordinary pump tube is to be removed from the well along with the pump and pump rod. This naturally requires that these parts be unscrewed into their constituent 20-foot sections and removed section by section. An acid supply pipe, which is to be lined with lead, rubber or enamel and similarly coated outside near its lower end, is then put together section by section and run into the well. This pipe carries a packer near its lower end by which the lower part of the well hole is supposed to be sealed off from the cased part of the well. Concentrated hydrochloric acid is then run down this pipe, followed by water to force it out into the formation, where it is supposed to attack and enlarge the pores.[11] After allowing the acid time enough to work, an alkali is to be forced down to neutralize any unspent acid, the acid supply pipe is removed, being necessarily broken into its constituent sections, the pump tube and pump rod are replaced section by section and pumping is begun or resumed.

2. A second reason why the process failed commercially no doubt was the use of concentrated hydrochloric acid. The Frasch patent recommends the use of from 1,000 to 2,000 gallons of acid containing "from thirty to forty per cent by weight of the acid gas HCl * * *." (R. 1936.) In the first treatment, made in August, 1895, to the Crosley well of the Ohio Oil Company, 65 barrels (2730 gallons) of concentrated acid were used. A letter from Frasch to Van Dyke, written about six weeks after that treatment, indicates that the acid used contained 27% or 28% HCl. The letter further shows that Frasch was seeking a still stronger acid. (R. 1889.) As previously stated, the preferred con-

[10] On this ground alone the Tenth Circuit Court of Appeals held the Frasch process to be commercially impracticable.

[11] That the acid probably did not so act see *infra*, pp. 33, 34.

centration of acid in the Grebe-Sanford process is 15% and that is what petitioner's licensees and respondent use in practice. The differences in the effect of concentrated and dilute acid solutions when used in oil wells are two-fold:

(a) Hydrochloric acid of the concentrations recommended and used by Frasch corrodes iron and steel five times faster than does 15% acid, thus causing greater damage to the equipment with which the acid comes in contact.[12] In the attempts made by Frasch and Van Dyke to commercialize the process the operator requested a new string of acid supply pipe after only four or five treatments in spite of the protective coating inside the pipe. (R. 1890.)

(b) Concentrated acid is more viscous than dilute acid[13] and reacts more violently with limestone. Consequently, it enters the small rock pores more slowly and expends itself on the walls of the well hole and the rock closely adjacent thereto. The resulting spent acid solution is a viscous concentrated calcium chloride brine[14] which must be forced out into the formation ahead of the incoming acid before fresh acid can enter and enlarge the pores.

(12) See Charts, R. 1802, 1842-45.

(13) The viscosity of hydrochloric acid solutions is given in the International Critical Tables of Numerical Data, Physics, Chemistry, and Technology published for the National Research Council by the McGraw-Hill Book Co., Inc., New York, New York, 1929, Vol. 5, page 12. For 5 formula weights of HCl per 1000 g. of water, a concentration corresponding to 15.4% HCl, the viscosity relative to water is 1.294 and for 11 formula weights of HCl per 1000 g. of water, a concentration corresponding to 28.6% HCl, the viscosity relative to water is 1.71. Thus 28.6% HCl is about 32% more viscous than 15.4% acid.

(14) The viscosity of the 19.8% calcium chloride brine, which results from spending 14.5% HCl on limestone, is given as 2.56 centipoises at 10° C. on page 105 of the Refrigerating Data Book, published 1942 by The American Society of Refrigerating Engineers, New York, N. Y. The viscosity of pure water at the same temperature is 1.3077 centipoises (page 1676, 24th Edition Handbook of Chemistry and Physics, published by Chemical Rubber Publishing Co., Cleveland, Ohio). The viscosity of the 34% calcium chloride brine which results from spending 27% HCl on limestone is given in the same data book as 8.164 centipoises at 10° C. Therefore, the spent solution from 27% HCl is more than three times as viscous as the spent solution produced from 14.5% HCl.

There the spent acid hinders the flow of oil to the well following the treatment.

3. Finally is the matter of financial return, which no doubt was uppermost in the minds of the well owners. The Ohio Oil Company was not satisfied with the gains from the first two wells treated. After three months operations there had been a gain of only $1200.00 in oil against an expense of over $1500.00 in connection with the two treatments. (R. 1897-99.) These figures included the increased yield from 5 to 35 barrels a day which resulted from pumping the Taylor well after the treatment.[14a] The third well treated for the Ohio Oil Company showed an increase of only seven barrels a day and the fourth well was not benefited at all by the treatment, whereupon the process was dropped insofar as that company was concerned.

Other possible explanations for the abandonment of the Frasch process will be referred to under the heading "Argument," but whatever the reason the fact remains that the process was a commercial failure and was so recognized by The Ohio Oil Company as well as by its promoters, Frasch and Van Dyke. (*Infra*, pp. 30, 31.) That the process did not fail because of lack of pressure appears from the report of the first treatment which shows a rock pressure of 400 or 500 pounds per square inch and a hydrostatic pressure of from 700 to 800 pounds on the acid column. (R. 1653.)

Frasch and Grebe-Sanford Results Contrasted

Frasch's fourteen treatments to producing wells showed a total initial gain of only 161 barrels, of which nearly one-half was in two wells, 30 barrels in one well and 43 barrels in another. The other twelve wells showed an

(14a) See footnote 9.

average initial gain of only 7.2 barrels per day, at the expense of very large amounts of concentrated acid.[15]

In marked contrast with the results obtained from these Frasch experiments are those obtained from treatments by the Grebe-Sanford process. The first treatment was inconclusive,[16] but the second treatment resulted in an increase from 30 to about 125 barrels a day, and the third treatment resulted in an increase from 90 barrels to 790 barrels a day. (R. 1018-19.)

This third Grebe-Sanford treatment added several times more oil production than did all of Frasch's treatments combined. From that time on the process met with overwhelming success. With no effort on the part of petitioner to push the adoption of the process, it swept the industry like wildfire within a few months after it was first introduced. Hundreds of letters of inquiry came in from oil companies all over the country, a small part of which are in evidence as Plaintiff's Exhibit 13. (R. 1597-1625.) Petitioner's principal licensee, Dowell, Inc., had employed the Grebe-Sanford process to treat more than 25,000 wells up to the end of 1940. (R. 1806.) The use of this process has added millions of barrels to our oil production and millions of dollars in income to oil producers, not to mention the tremendous increases in the production of fuel gas which have resulted from its use. (R. 191, 1796, Ex. 328.)

While it is impossible in many cases to give comparative figures, they are given for a considerable number of individual wells and also for groups of wells and show that the results of the Grebe-Sanford process were consistently

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(15) 65 barrels (2730 gals.) of concentrated acid were used in the first Frasch treatment, 108 carboys (1080 gals.) in the second and apparently a large carload in each subsequent treatment. (R. 1651, 1658, 1903-4.)

(16) In the first Grebe-Sanford treatment the acid charge was divided into four 125-gallon shots with the probable result that the acid spent the greater part of its strength on and near the walls of the well hole and did not penetrate the formation sufficiently to materially increase production. (R. 1795.)

successful to a degree never approached by anything obtained from the Frasch process. Taking a few more Grebe and Sanford treatments whose initial gains are shown, we find the following: One well with an initial production of 125 barrels was increased to 1070 barrels a day initially, and after five days was producing better than 500 barrels a day. Another well which when new showed an initial production of 210 barrels a day was increased to 1700 barrels a day, and a third well which had been plugged and abandoned as dry several months before the treatment flowed 348 barrels of oil in 22 hours after the treatment, made 200 barrels the second 24 hours and continued to *flow* at from 100 to 175 barrels per day. (R. 149.)

Taking other treatments as they come in the record, we find an average gain of 20 barrels per well per day from 30 wells *over a period of one year*, despite conservation restrictions (R. 216), and an average gain of 23 barrels per day from 125 wells. (R. 219.) At page 222 is a table showing *average* daily gains of 106 barrels, 38 barrels, 60 barrels, 46 barrels, 75 barrels, 84 barrels, 55 barrels and 43 barrels from a group of eight wells. Two other wells showed initial gains of 650 barrels and 190 barrels per day, respectively (R. 231, 233), and the average initial gains in 41 wells examined as a group was 69 barrels per day and of ten other wells was 170 barrels per day. (R. 233.)

The Operations of Oil Makers Company and Chemical Process Company

Shortly after the success of the Grebe-Sanford process was demonstrated in an oil field near the Dow plant a concern known as the Oil Makers Company began to acidize wells in that and other Michigan fields. Testimony regarding this operation is utterly immaterial on the issue of validity. It was not prior art, nor was it such a reproduction

of the Frasch process as to prove that it could have been revived and made successful. Yet the Court of Appeals treated it as though it were the Frasch process, which it plainly was not. It was a wholly different process developed in the light of Grebe and Sanford's success, and employing two of the three new features of the Grebe and Sanford process, *viz.*, the use of dilute acid and the introduction of the acid through the pump tube. In the first of these treatments dilute (15%) raw acid was used, but this did so much damage to tubing and other well equipment that inhibited acid was adopted and used in the greater part of the treatments.

Concentrated hydrochloric acid, depending upon the exact degree of concentration, is from 2½ to 5½ times as corrosive to mild steel as was the 15% acid used by Oil Makers Company. If Frasch's concentrated acid had been employed it would have been absolutely impracticable for Oil Makers Company to introduce it through the pump tube, and had it done so there is nothing in the record to support an assumption that it would have had any better success in increasing yield than did Frasch. So far as the record shows, nobody has ever attempted doing such a thing as a regular practice.[17]

Because of its highly corrosive character, it would be impossible to apply pressure to concentrated acid by any normal means, such as a pump. Furthermore, the introduction of concentrated acid into a well hole would institute a vicious circle which would interfere with and effectively prevent the accomplishment of the result which Frasch had in mind, *viz.*, the enlargement of the rock pores

[17] In one operation the owner of a well used 100 gallons of raw hydrochloric acid. The language indicates that this was poured into the tubing, in which case it no doubt was concentrated acid, poured out of carboys. As a result of the use of even this small amount of acid, the tubing was destroyed so that later on inhibited acid could not be pumped through it under pressure, and new tubing had to be supplied. (R. 232.)

at a distance from the well hole so as to provide a freer flow of oil to the well. To start with, concentrated acid is more viscous than dilute acid and, therefore, it would penetrate the rock more slowly under equal pressures. Next, concentrated acid reacts more violently with limestone than does dilute acid and as this reaction proceeds the resulting solution becomes more and more viscous through the formation of calcium chloride which is taken up by the solution. Therefore, if concentrated acid were used it would expend much of its strength on the walls of the well hole and the immediately surrounding rock and the resulting viscous solution of spent acid would have to be forced back into the pores ahead of the unspent acid before those pores could be attacked and enlarged. Finally, this viscous spent acid solution would have to be forced out of the pores by the natural rock pressure before oil could pass through them and into the well. The poor results obtained from the Frasch experimental treatments indicate that this is what actually occurred and that the large quantities of concentrated acid used in the Frasch experiments did nothing more than to enlarge the well hole and the pores of the rock immediately surrounding it and to leave the smaller pores clogged with spent acid solution where it obstructed the flow of oil to the well.

Using the comparatively innocuous and free-flowing uninhibited 15% acid, the Oil Makers Company naturally got some satisfactory increases in production without immediately apparent damage to well equipment, but the acid was sufficiently damaging to the tubing that a considerable number of complaints and claims for damages resulted. So much trouble was caused that the Oil Makers Company soon

shifted to the use of dilute inhibited acid, after which their process became a clear infringement.[18] This shift took place almost simultaneously with the issue of the patent in suit, and in the face of that patent and the low price of oil their business faded away. (R. 1238.)

Oil Makers Company made 26 acid treatments with 15% uninhibited acid before they shifted to the directly infringing method and thereafter made a much larger number of treatments with inhibited acid.[19] In these 26 operations, there was definite and ascertainable damage to the equipment in about half the wells. The man who made those treatments quit working for Oil Makers because of this damage. He testified (R. 1271):

> "***We were causing more damage than we were making money to pay for. I also told them (his associates) that unless we found some way to use the acid without causing so much trouble to the steel material in the well, that it was useless to continue to use it."

Chemical Process Company started in business in Texas in the fall of 1932, following the practice of the Oil Makers Company with which it was familiar. It used dilute acid in all its treatments and admittedly used an inhibitor in some of them. It claims to have used only raw acid after the Grebe-Sanford patent was sustained in

[18] Complaints were made on the following wells treated by Oil Makers in July and August of 1932, before any inhibited acid was used. Wells and Malcolm's Hastings No. 1 (R. 1259); Stork Oil Co.'s Coon No. 4 (R. 1263); G-Lee-P Co.'s Schaeffer No. 1 (R. 1263,4); McClanahan Co.'s Schaeffer No. 1 and Struble No. 2 (R. 1269); Schuller's Reimenschneider No. 1 (R. 1267, 8), and Gordon Oil Co.'s Tanker No. 1 (R. 1269). In addition, cash settlements for damage or free treatments in settlement for damage claims were made with Gordon Oil Co. (R. 1203-9), Moline Investment Co. (R. 1204), Stork Oil Co. (R. 1204, 10, 11), Malcolm and Stork (R. 1205-6), Malcolm Oil Co.—3 wells—(R. 1206, 7, 12), G-Lee-P Co.—2 wells—(R. 1207, 12), Columbia Oil & Gas Co. (R. 1211) and Cliff Warner—2 wells—(R. 1211).

[19] A total of about 250 wells were treated. (R. 1195.) Proven purchases of acid were: Raw acid $1,220.80 (R. 1196-7); inhibited acid $4,145.71 (R. 1199-1200).

the *Williams* case (R. 1004), but this claim is supported only by the testimony of one interested witness, the vice president of the company, and is in conflict with the testimony of another witness who investigated the operations of that company in 1939 and found rolls of sheet lead in its acid delivery tanks, similar to those contained in respondent's tanks. The unavoidable effect of the presence of sheet lead in the acid delivery tanks is the development of inhibitors (copper and lead chlorides) in the acid before it is introduced into the pump tube. (R. 1302-6.) These are the identical inhibitors that were present in respondent's acid in the process which both lower courts held to infringe. As in the case of the Oil Makers Company, these operations were neither prior art nor the Frasch process.

The Gypsy Oil Company's Scale Removal Experiment

This brings us to the attempt of Gypsy Oil Company in 1928-29 to remove calcium carbonate scale (called gyp) from the tubing in some of its sandstone wells by the use of concentrated hydrochloric acid. The Tenth Circuit Court of Appeals considered this alleged prior use on substantially the same evidence as that here present and held, first, that it showed nothing more than an unsuccessful and abandoned experiment, and, secondly, that it would not have anticipated even if fully established as a prior use. The courts here held it to be a successful prior use *anticipating* the patent in suit.

In the instant case, a little additional testimony was taken, but it added nothing to the facts, and certainly nothing that was not fully admitted in the Tenth Circuit. The only reliable evidence of the Gypsy experiment is that contained in contemporaneous written recommendations, reports and correspondence, and this evidence is identical in

both records. In addition, the depositions of Case, Wright, Kiser and Knappen in the Williams case were stipulated into this record.

The two courts simply differ in their legal interpretation of facts which are clearly proved by evidence stipulated into this case from the earlier one. The Court of Appeals in this case refers to testimony by Dr. Wescott which was not before the Tenth Circuit.[20] The part alluded to is his statement that the use of inhibitors to protect metal from attack by hydrochloric acid was well known at the date of the Gypsy experiment. (R. 2057.) This was openly and frankly conceded at all times in the Tenth Circuit. Indeed, we not only conceded but we stressed the fact that although inhibitors were very well known and in active use right under the eyes of many oil producers, they never thought of using them for the purpose for which Grebe-Sanford employed them.[21]

The Gypsy Oil Company in 1928, was producing oil from *sandstone* in the Glenpool field in Oklahoma, and was having trouble from the formation of a lime deposit, called "gyp," on the pump tubing, valves and casing. (R. 1665.) The usual way of coping with the problem was to withdraw the tubing from time to time and clean it mechanically. The company wanted to avoid this inconvenience, and to clean the tubing while in place. To this end, it referred the problem to the Mellon Institute, whose conclusions and recommendation were embodied in a formal report by Dr. Wescott. This is printed in both records but it was *not a public record* at the date of the Grebe-Sanford invention. (DX-151, R. 1908.)

[20] The only additional evidence here is a second deposition by Knappen and a deposition of the chemist Dr. Wescott who recommended the scale removal treatment in question. Neither of them witnessed any of the treatments relied on to establish this prior use and both frankly admit that they secured their information from the reports and correspondence, which are identical in both records. In his new deposition, taken in 1941, Knappen said his memory of events was better in 1934, when he gave his first deposition. (R. 1086-7, 1091, 1102, 1111-13.)

[21] In his deposition in the *Williams* case defendant's witness Knappen testified that his company had used inhibited hydrochloric acid from 1920 on for the removal of calcium carbonate scale from the cylinder blocks of engines. (R. 1078.)

The report discussed at length the formation of scale and its composition and concluded by recommending that an attempt be made *in one well* to dissolve the scale by the use of inhibited concentrated hydrochloric acid. (R. 1921.) The report stated that while many inhibitors were satisfactory with *dilute* acid, special tests had been made with concentrated acid and that a commercial inhibitor known as Rodine should be used with such acid.

For the removal of the Gypsy scale this recommendation of concentrated acid was doubtless sound. The scale formed a thick deposit on the surface of the well casing and tubing (R. 1910) and a weaker acid would have been neutralized before it had eaten through the scale. However, it was recognized that the acid might attack the producing sandstone formation, dissolve the binder and free a large amount of sand, which would fall into the well hole. What was desired was a vigorous reaction on the scale, and the record shows that the operators took great precautions to prevent the acid from getting into the rock. (R. 1682.) It was recommended that the acid be permitted to "trickle down the casing and be immediately pumped out through the tubing." (R. 1681.)

The first Gypsy test was made on November 12, 1928, on Berryhill No. 8 well and resulted in the pump being choked with sand as had been feared, so that it was "necessary to pull the pump several times in order to get the well to pumping normally." (R. 1683.) This test was fully reported, and it is the only one of the tests relied on to prove this experiment concerning which there is anything but oral testimony. One report states: "The first experi-

ment with the acid has been run at Glenpool with unsatisfactory results." (R. 1683.) A further discussion of the same test states: "The treatment has apparently not benefited the well production." (R. 1684.) A further report states: "The production of the well, however, has not increased. * * * However, it is doubtful if production can be increased." (R. 1686.) A later letter states "No improvement in oil production has been shown." (R. 1687.)

Following this first test the Gypsy Company, in 1929, is said to have treated six additional wells with acid to remove scale. In two of them the inhibitor Rodine is said to have been employed as in the first test. In three of them acid is said to have been used without an inhibitor. In one of them a material of utterly unknown composition, known as Armine, was used. There are no written reports of these treatments and they were testified to by only one witness, Kiser, whose testimony in the Tenth Circuit was copied into this record. (R. 1075-77.) Gypsy is said to have made two more of these treatments, in neither of which was an inhibitor used. (R. 1075-6.) One is said to have been made in 1930 and the last one on March 10, 1931. (R. 1075-6.)

Thus, there is some evidence regarding ten different tests, but we have a good description of only the first one. The record is silent as to the steps followed in the other nine and as to the results obtained. In only three of the ten is it claimed that an inhibtor was used. In some it is said that no inhibitor was used, and as to some we have no information. These tests were reported to be unsatisfactory, the whole scheme was dropped, and other experiments along different lines were undertaken.

In the summer of 1931, an experiment of a different kind was carried out on the Anderson No. 3 well, in an effort to prevent scale formation, rather than to remove it. In this operation, also approved by the Mellon Institute

(R. 1691), the acid was slowly and continuously lubricated in to the casing over a considerable period of time. As demonstrating the uncertainty of operations far underground, this test increased rather than diminished scale. (R. 1690.)

Finally, in October, 1931, a test was made to remove the scale with a mechanical scraper, which was sufficiently successful that its use in other wells was recommended. (R. 1693.) That the gyp problem was not considered solved by the experiment relied on appears from a letter written in July, 1932, which shows that Gypsy was still trying to find a means for preventing its formation. (R. 1698).

During all this period the same Gypsy Oil Company, only a short distance away, was operating limestone wells which would have been enormously benefited by the Grebe-Sanford process. When the success of that process became generally known, Gypsy was one of the first large oil producers to turn to the Grebe-Sanford process to increase the production of its limestone wells.

Subsequent to July, 1931, and until it made use of the Grebe-Sanford process, no well of Gypsy Company was treated for any purpose with acid of any kind, inhibited or uninhibited. When Gypsy learned of the success of the Grebe-Sanford process, its general superintendent promptly wrote to Dowell, Inc., under date of January 19, 1933, inquiring when it would be in a position to treat wells in Gypsy's Kansas area. (R. 1704.) As a result Dowell, Inc., soon commenced applying the Grebe-Sanford process to Gypsy's limestone wells. It made its first treatment for Gypsy on February 10, 1933, and has continued to treat wells for Gypsy up to the present time. Prior to November 10, 1933, Dowell had treated nine other wells for Gypsy and up to the time Knappen testified in the Williams case in 1934 about 75 other Gypsy wells had been similarly treated.

(R. 1088.) Up to 1941 Dowell, Inc., had treated a total of 348 wells for Gypsy Oil Company. (R. 1405.)

SUMMARY OF ARGUMENT

1. New proofs in this record fully establish the soundness of the conclusion of the Tenth Circuit Court of Appeals that the process of Frasch patent 556,669 "was cumbersome and expensive, and probably impracticable * * *." They show that men eminent in the oil industry made a resolute attempt to commercialize that process about the time the patent issued and that the effort was discontinued after thorough trial. The Ohio Oil Company, one of the then largest oil producing companies, tried the process in four of its wells before abandoning it. Thereafter the owners of the patent tried it over a period of eighteen months in a dozen other wells of as many different owners with the result that it was then completely abandoned and never revived. After the lapse of more than a third of a century, during which period the number of limestone fields greatly increased and the need for such a process grew, the invention of the patent in suit was made and became a spontaneous and spectacular success, producing in the third treatment and with only a small fraction of the acid used in the Frasch treatments a greater increase in production than resulted from all the Frasch treatments combined.

Petitioner, having proved beyond any doubt that the Frasch process was a commercial failure, is not charged with proving why it failed. Certainly it was not due to lack of funds or opportunity. Its owners and promoters were eminent men of wide experience and influence in the oil industry and their trial treatments were given extensive publicity. The need for a practicable process for increasing the production of oil from limestone fields existed before the Frasch process was tried, it grew steadily with the

opening of new limestone fields, the means for solving the problem were at all times readily at hand, and yet the solution remained a mystery and the need unsupplied until Grebe and Sanford disclosed their simple solution in 1932.

The failure of the Frasch process can be explained only on the theory that it had inherent defects.

2. The raw acid process used by the Oil Makers Company for a few months, and said but not proven to have been used by Chemical Process Company, was not the Frasch process at all, but a new process which utilized two of the three features which distinguish Grebe and Sanford from Frasch and to the use of which features must be attributed whatever success those companies may have obtained from the use of raw acid as compared with Frasch's dismal failure. Both those companies came into existence after the Grebe-Sanford process had become a recognized success and was being widely used; hence their practices, whatever they were, are not prior art.

The use of raw acid by Oil Makers Company resulted in so much damage to well equipment that at the end of a few months it was obliged to change to the more expensive inhibited acid, thereby becoming a direct infringer of the patent in suit.

The use of uninhibited acid at any time by Chemical Process Company is not established. It is supported only by the uncorroborated testimony of a single interested witness and is opposed by positive uncontroverted proofs, including physical exhibits, that the steel tanks in which that company transports its acid to the wells contain quantities of lead sheets, as do defendant's tanks, the only purpose of which and the inevitable result of which is to produce in the acid the identical inhibitors—lead and copper chlorides—which are used by defendant in its infringing process.

3. There is no factual evidence in this record regarding the Gypsy use of hydrochloric acid in its scale removal

attempts that was not before the Tenth Circuit Court of Appeals when that court held this alleged prior use to be nothing more than an abandoned experiment and in any event not anticipatory, yet the Sixth Circuit Court of Appeals held it to be both a commercial success and an anticipation. All the evidence on this subject in the Tenth Circuit case was stipulated into this record and the only new evidence here is a second deposition by Knappen, taken seven years after he testified in the *Williams* case, and a deposition by Wescott. Each testified that he had not witnessed any of the tests relied on by defendant to establish this prior use and that he depended for his information on the correspondence and written reports, which are identical in both records.

The objects, procedures and results in the Gypsy and Grebe-Sanford processes are entirely different. Gypsy was concerned with the removal of "gyp" deposits from the pump equipment in sandstone wells and endeavored to keep the acid from entering the sandstone formation, whereas the Grebe-Sanford process is designed to enlarge the pores of the producing formation in limestone wells to facilitate the flow of oil to the wells. Gypsy used concentrated acid which was five times as corrosive to mild steel as is the dilute acid used by Grebe-Sanford. Gypsy used only enough concentrated acid to fill the well tubing and the space between the tubing and well casing, and let it stand there long enough to eat its way through the scale. Grebe and Sanford use a large volume of dilute acid which they do not permit to enter the space between the tubing and casing. Gypsy took precautions against passage of the acid into the formation, whereas Grebe and Sanford force the acid through the well tubing and out into the formation as quickly as possible. The Gypsy treatments did not increase the production of oil, whereas the sole object of the process in suit is to increase production.

In only three of the Gypsy experiments was an inhibitor used in the acid. The last Gypsy experiment to remove gyp with *inhibited* acid was in September, 1929, and the last one with *raw* acid was in March, 1931, after which Gypsy tried various other means for removing scale from its wells.

Gypsy learned of the success of the Grebe-Sanford process in January, 1933, and immediately wrote plaintiff's licensee regarding treatments to its wells. It began using the Grebe-Sanford process early in February, 1933, and by the end of 1934 had used that process with marked success in nearly one hundred of its wells.

ARGUMENT

In support of its finding of invalidity the Sixth Circuit Court of Appeals relied on (1) the Frasch patent and a few experimental applications of the process of that patent in 1895-97; (2) acidizing treatments made by Oil Makers Company and Chemical Process Company, subsequent to the introduction of the Grebe-Sanford process, which the court assumed to be a revival of the Frasch process, and (3) the experiments of the Gypsy Oil Company on three wells during 1928 and 1929 for the removal of "gyp" scale from the equipment in sandstone wells by the use of inhibited concentrated hydrochloric acid.

Petitioner contends that the record shows the Frasch process to have been a commercial failure, that the practices of Oil Makers Company and Chemical Process Company were neither the Frasch process nor prior art, and that the operations of Gypsy Oil Company were nothing more than an abandoned experiment which *would not have anticipated even if fully established.*

POINT I. THE FRASCH FAILURE

The following facts regarding Frasch are clearly established by uncontroverted proofs:

(a) The Frasch patent recommends the use of from 1,000 to 2,000 gallons of hydrochloric acid containing from 30% to 40% HCl. In his actual treatments Frasch used from 2,100 to 4,200 gallons (50 to 100 barrels) of raw acid containing 27-28% or more HCl, except in the second treatment where 1080 gallons were used. (R. 1652, 1889.)[22]

(b) The method employed by Frasch for practicing his process was cumbersome and the equipment used was short-lived because of the highly corrosive action of the concentrated acid used.

(c) The average *initial* increase in production that resulted from Frasch's treatments of 14 producing wells was only 11½ barrels per well per day, with no evidence to show how long these increases held up. (R. 1651, 1657-63.)[23]

(d) The Ohio Oil Company discontinued the use of the Frasch process early in 1896, after four of its wells had been treated with an average initial increase of 10 barrels per day, and criticized the expense in comparison with the results obtained from the first two treatments, one of which flowed 5 barrels a day before treatment and pumped only 35 barrels a day after treatment. (R. 1897-99.)

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[22] Hydrochloric acid is a solution of hydrochloric acid gas—HCl in water. It is most commonly made and shipped in the following strengths:

18° Baume, containing 27.75% HCl.
20° Baume, containing 31.45% HCl.
22° Baume, containing 35.21% HCl.

American Chemical Society monograph 36. Hydrochloric Acid and Sodium Sulfate by N. A. Laury, published by The Chemical Catalog Co., Inc., 1927, pages 17, 27 and 49.

[23] Two of these wells were not helped at all and two dry wells were not benefited. This average includes the 30-barrel increase of the Thomas well of the Ohio Oil Company which was *flowing* at the rate of 5 barrels a day before the Frasch treatment and made only 35 barrels a day when *pumped* after the treatment. (R. 1657, 1897.)

(e) After twelve other treatments to wells owned by as many different parties over a period of about two years the Frasch process was dropped in 1897 and never again used, although the owners, Frasch and Van Dyke, were men of prominence and influence in the oil industry and in position to continue and extend the use of their process had it been a success.

(f) The Frasch treatments were given wide publicity. As long as they were being carried on a series of puffing articles appeared in the Oil City Derrick, the then leading oil journal, indicating that the process was expected to be a great boon to the oil industry; yet suddenly, with no published reasons, the articles stopped and the process passed into the limbo of tested and proven commercial failures. (R. 1651, 1656-63.)

(g) The need for some such process during the thirty-five years that elapsed between the last Frasch treatment and the first Grebe and Sanford treatment was urgent, due to the increase in the number of limestone fields from a few dozen to more than 400 and also to the fear of oil exhaustion during a large part of that period. (R. 28 and PX-192.)

In sharp contrast to these established facts with respect to the Frasch process are the following equally well established facts with respect to the Grebe-Sanford process:

(a) In their early treatments which established the success of the Grebe-Sanford process they used only 500 gallons of 15% acid—from ¼ to 1/12 of the acid ingredient (HCl) used in the Frasch treatments. (R. 1591.)

(b) 27% or 28% HCl solutions, such as used by Frasch, are five times as corrosive to mild steel as is the 15% solution used by Grebe and Sanford[24]

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[24] Raw acid of the strength used by Frasch will dissolve 1.38 lbs. of steel per square foot of surface per day, raw 15% acid at the rate of only 0.263 lb. per day. (R. 1802.)

(c) The second and third Grebe-Sanford treatments gave initial increases from 30 to 125 barrels a day and from 90 to 790 barrels a day. (R. 1618-19.)

(d) The Pure Oil Company, which owned the first wells treated by the Grebe-Sanford process, continued to be a large user of the process, more than half of the 250-odd wells treated during the first six months having been owned by that company. (R. 1591-6.)

(e) The results obtained from the Grebe-Sanford process were so outstanding that they soon became known to the oil industry without effort on behalf of petitioner and inquiries came from oil producers all over the country, including many of the largest oil companies. (R. 144-5, 1597-1625.) This necessitated the formation of a separate subsidiary corporation, Dowell Incorporated, and the establishment of treating stations in many states to handle the demand for treatments. (R. 127-8, 1655.)

Why Frasch Was Abandoned

The record does not clearly show why the Frasch process was abandoned, nor is the burden on petitioner to show the reason. Respondent advances the Frasch patent and the use of the Frasch process in a few wells as its main defense, and the burden should be on it to account for the abandonment of that process on some theory other than that it was a commercial failure. This it has not done. But, although we do not have any direct proof on this subject, the record is not wholly devoid of indications as to the cause of the failure of the Frasch process.

1. The concentrated acid used was so intensely corrosive as to compel the costly and cumbersome expedients which Frasch used to get it into the well. (*Supra*, p. 13.) Their efforts to protect the acid supply pipe from this strong acid by lining it throughout and coating the outer

surface of its lower part with an acid-resistant material obviously were failures. After only five treatments one set of acid supply pipe was so badly corroded as to be useless. The rubber manufacturers said they could not provide the rubber protective layer suggested in the patent, and it is almost self-evident that however one might try to line the lengths of pipe, the screw threaded joints could not be protected and would inevitably be destroyed after a little use. Corrosion of the screw threads would create grave danger that the string of pipe would part, and that would require a difficult if not impossible effort to recover the lost part by fishing for it hundreds and even thousands of feet underground. Furthermore, the suggestion that the acid be prevented from rising to the height of the casing by means of a packer was not practicable, as pointed out by the court in the Tenth Circuit.

2. The high concentration of the acid used by Frasch was no doubt responsible for an even more serious defect in that process—*viz.*, the failure to produce increases in production sufficient to justify the expense of the treatments. Concentrated acid reacts with limestone much more quickly and violently than does dilute (15%) acid. Consequently, unless the concentrated acid is to expend itself on the walls of the well hole and the pores of the immediately surrounding rock it should flow with sufficient ease and have enough pressure back of it to force it quickly out into the formation. But several causes inherent in the use of concentrated acid would cooperate to prevent this. In the first place, concentrated acid flows less freely than does dilute acid; in the second place, Frasch had to rely and did in fact rely on the hydrostatic pressure of the column of acid in his one-inch acid supply pipe, because no suitable pump could handle such strong raw acid;[25] in the

(25) The Oil Makers Company ruined a pump in a few treatments with uninhibited acid of but 15% concentration. (R. 1265.)

third place, concentrated acid forms and takes up calcium chloride with much greater rapidity than does dilute acid and the higher the percentage of calcium chloride in the spent acid the more viscous it becomes; and, finally, this spent acid would have to be forced back into the formation ahead of the incoming fresh acid before the latter could reach and attack the pores in the formation away from the well hole. All these conditions would contribute to slow down the movement of the acid back into the formation and thereby tend to defeat the object Frasch sought to accomplish.

3. Another possible explanation of the unsatisfactory increases that resulted from the Frasch treatments was the difficulty of removing this viscous spent acid from the pores of the rock. It had to be forced out ahead of the oil by the natural rock pressure and to the extent that this spent acid remained in the pores the flow of oil to the well hole was blocked or lessened.[26]

In the light of the foregoing, it is not strange that the Frasch process was abandoned. While technically operative to clean the walls of a well hole and open the pores at that point, it was not capable of successfully carrying out Frasch's object of enlarging the pores of the rock "at a distance from the original well hole."

So far as teaching the industry anything, this old patent, the experimental treatments thereunder and the publicity given to them were worse than useless.[27] In

[26] That concentrated HCl is more viscous than dilute HCl and that the brine resulting from the reaction of concentrated HCl on limestone is much more viscous than was the unspent acid are well known facts of chemistry, and that Frasch relied on the hydrostatic head of his column of acid to force the acid back into the formation clearly appears from the Frasch patent and the reports of the Frasch operations. (See footnotes 13 and 14, and *infra*, p. 41.)

[27] That these treatments were considered to be experimental by those connected with them clearly appears. They are so referred to in the published articles and in the Ohio Oil Company correspondence. (R. 1656, 1657, 1659, 1896 and 1897.)

their absence others might have tried acid treatments and eventually have been successful. But when Frasch and Van Dyke, who knew all about the patent and the efforts to commercialize the process, deliberately and permanently abandoned all efforts at any kind of acidizing, their standings in the chemical and oil industries were such as to discourage any later attempts. Surely Frasch and Van Dyke would not have discarded an open sesame to untold wealth unless there was some "bug" in the scheme which defeated its purpose. With the best of chemical and petroleum technical skill at their command and with unlimited opportunities for making experiments, they would have eliminated the "bugs" if they could have been eliminated as easily as the lower courts assumed. The practical failure of the Frasch process, when tried by such eminent men as Frasch and Van Dyke, and the publicity given their experiments, undoubtedly served to deter others from attempting to increase oil production by acidizing the formation.

The tremendous difference in the over-all results from the Frasch and Grebe-Sanford processes demonstrates that they are not the same or even closely similar and refutes the soundness of the conclusion reached by the courts below that Grebe and Sanford merely revived the old Frasch process with the addition of some slight changes of trifling importance which added somewhat to convenience and cheapness of operation but which should have been obvious to anyone skilled in the art.

This theory simply cannot be true. Had the Frasch process possessed the elements of success it would have succeeded commercially with the backing it had. If the tests made had not convinced its promoters of its impracticability, or if the means of avoiding the defects had been so apparent as the lower courts assumed, they surely would have given it further trials.

The two processes must, therefore, be carefully compared to see what the differences are which could make one a commercial failure and the other a spectacular commercial success. In considering this, we must always remember that the oil producer is interested in absolute increases of his yield in barrels.

The Grebe-Sanford process in its preferred form, as covered by claim 8, differs from the Frasch process in three respects:

First, Frasch in his patent taught the use of commercial concentrated hydrochloric acid containing from 30% to 40% HCl, and actually used in his first treatment acid containing from 27% to 28% HCl, whereas Grebe and Sanford in their patent taught the use of hydrochloric acid containing only 5% to 20% HCl and actually used 15% HCl. This dilution alone substantially reduced the viscosity of the acid, greatly slowed its reaction on limestone, thus allowing the acid to open up channels distant from the well hole, and greatly reduced its corrosive action on iron and steel. (R. 1802.)

Second, positively to insure the acid against damaging corrosive action on iron and steel, Grebe and Sanford added to it an inhibitor which quite effectively prevented attack by the acid on the metal equipment of the well without interfering with its intended action on the rock. Such inhibitors were well known to chemists long before Frasch's work, and have been constantly used ever since. But Frasch and his associates never thought of using them, and nobody else prior to Grebe and Sanford ever again tried to increase the production of a well by treating the producing formation with acid, either raw or inhibited.

Third, having thus rendered their acid innocuous, Grebe and Sanford introduced it through the ordinary pump tube already in the well, and thus eliminated the costly, cumbersome and, as found in practice, ineffective method of introducing it through a specially protected acid supply pipe. Not only was Frasch's pipe impracticable because it could not be made proof against attack by the acid at the joints, but it was far too small to hold the acid charge, thus making it practically impossible to apply pressure other than that resulting from the weight of the acid column. No suitable pump then or now known could be used to pump concentrated acid.

Fourth, although Frasch's concentrated acid reacted much faster with the rock and so should have been forced in much faster to prevent its spending most of its strength enlarging the well hole and the pores close to the hole, inherently it went in much more slowly under comparable conditions. Concentrated acid being about one-third more viscous than the dilute acid of Grebe and Sanford, under equal pressures will flow only at about two-thirds of the speed of their dilute acid.

While Frasch's patent suggests (R. 1936, ls. 38-9) that other pressure means may be used, Frasch *actually* relied entirely on the hydrostatic head of his acid in the supply pipe to get the bulk of it into the rock. In his experiments, having pulled the pump tubing and inserted his one-inch diameter acid pipe, he had a tube which in a well of the depth in the Lima field (about 1200 feet) would hold only about one barrel of acid.[28] At the top of his acid pipe Frasch shows a funnel-shaped box. Assuming this to be kept full of acid, only the weight of the full column would press the acid out into the rock. Frasch's acid, therefore, entered the rock only as fast as the head of acid would drive it, and this rate was necessarily quite slow.[29] The

[28] According to accepted engineering tables the capacity of a one-inch pipe is 0.0408 gallons per foot of length.

[29] Defendant's Exhibit 105 (R. 1894) states that the treatment to the Crossley well of the Ohio Oil Company was begun on August 5th and finished on August 10, 1895.

Frasch correspondence speaks of dumping the acid (R. 1885 and 1887) and of pouring the acid (R. 1891, both expressions consistent only with the use of a gravity head produced by the flowing column of acid in the supply pipe. The latter of these letters, from the operator to Van Dyke, states that permission had been obtained to use a pump on the premises "to pump the oil and water with," but never is there mention of pumping the acid.

Acid neutralizes itself quite quickly in the fine pores of limestone, which present enormous surfaces to be acted upon. It is usually spent in an hour or less and the record shows one case where it was proved to be spent in 20 minutes. (R. 203; see also R. 284.) Hence, acid introduced slowly, as in the Frasch experiments, would spend itself close to the well hole and the acid which follows would drive the still more viscous spent acid ahead of it while further enlarging the well bore and closely adjacent pores. At the end of his operations Frasch followed his acid with water under pressure, but the only acid this could have driven out into the rock was the viscous spent acid already there and in the well hole and a small quantity of fresh acid, about one barrel, held in the acid pipe.

The Grebe and Sanford procedure is radically different, aside from the fact that their fresh as well as spent acid is less viscous and flows easier. In their earlier operations and many of the later ones, the pump tube took the entire charge of acid,[30] but this is of minor importance in the Grebe-Sanford process because the dilute inhibited acid used can be and commonly is pumped into the well tubing. (R. 265, 287.) As soon as all of the acid has entered the pump tube, whether it is poured in or pumped, oil is pumped under heavy pressure down the tubing behind the acid (R. 1502, lines 78-82 and R. 287), driving it compara-

[30] A three-inch pump tube holds 0.3672 gallons per foot of length, and a two-inch tube 0.1632 gallons.

tively quickly out into the fine pores before it has time to spend its strength on the rock in and near the bore.

Briefly, the concentrated acid Frasch introduced slowly reacted quickly with limestone, whereas to enlarge the pores away from the well it should flow in especially fast. Yet, because of the inherent nature of the Frasch operation, the acid actually must enter the rock comparatively slowly. Grebe and Sanford, using a freer flowing but slower acting inhibited acid, can and do drive it in comparatively rapidly.

The record, of course, shows that wells differ in the permeability of the rock and even with high pressure the introduction of the acid varies over a wide range. Speed of introduction is always advantageous, and, in the same kind of rock Grebe and Sanford can always get a far quicker dispersion of the acid than Frasch could possibly have attained in the same formation.

Due to the differences above enumerated the Grebe-Sanford process brought practical success and wide adoption, whereas the Frasch process proved to be a failure not only commercially, but as a method of increasing production. Examination of the actual operations demonstrates an enormous difference in results, which in turn shows beyond a doubt radical differences between the two processes.

In setting up a prior process as an anticipation or as prior art to negative invention the burden is heavily on the party advancing it to prove similarity. The court should not be required to speculate as to the reason for such striking differences in results as exist between these two processes, which operate far below ground where nobody can see what happens. Respondent must prove substantial identity. (*Radio Corporation vs. Radio Engineering Laboratories*, 293 U. S. 1, 7, 8.) This it has signally failed

to do. The results, on the contrary, demonstrate the existence of important differences in underground operations.

Frasch actually used from two to eight times the volume of HCl that Grebe and Sanford used. Viewed economically, Frasch's acid, gallon for gallon, contained twice as much HCl as that of Grebe and Sanford and would cost twice as much, and his total charge of acid would cost from four to twelve or more times as much as the charges used by Grebe and Sanford in their early treatments when the success of their process was demonstrated, entirely aside from the saving effected by reason of their simple mode of introducing the acid.

Yet, Frasch's results were miserably poor. His first well, treated with 2,720 gallons of concentrated acid, showed a gain of only three barrels a day. His second treatment, with 1,080 gallons of concentrated acid converted a well which was flowing at the rate of 5 barrels a day into one which had to be pumped after the treatment and gave an initial production of only 35 barrels a day. This was one of his two best tests. Frasch's third treatment (with a carload of concentrated acid, actual amount unknown, but probably near Frasch's upper limit of 4,000 gallons) produced an initial gain of only 7 barrels a day. The third treatment with the Grebe-Sanford process, with but a small fraction of the bulk of acid Frasch used and a still smaller fraction of active acid (500 gallons of 15% acid), produced an initial gain of 700 barrels a day. This and other early successes of the Grebe-Sanford process naturally led to overwhelming commercial approval and adoption.

The record does not show the initial gain in most of the individual wells treated by the Grebe-Sanford process. Most of the evidence was directed to the over-all gain in oil production, number of wells treated, long time gains in various wells and fields, etc. In an acidized well as in a new

well production gradually falls off, and since there are no long time production figures on the Frasch treated wells, we cannot compare with them.[31] Furthermore, average gains of wells treated by petitioner's process do not indicate the full gain because conservation laws have often held down production below obtainable maxima.

The only possible comparisons are between the initial gains which Frasch made and initial gains made by such Grebe and Sanford operations as happen to be shown at various places in the record. Frasch made 16 treatments, of which two were dry holes which remained dry after treatment. These two are omitted to give a fair picture. Of the fourteen other treatments, three have already been considered, leaving eleven more treatments the initial per diem gain from which were as follows, in the order of the dates of their published descriptions: 0 barrels, 5 barrels, 8.5 barrels, 9 to 12 barrels, 0 barrels, 10 barrels, 12.5 barrels, 13.5 barrels, 43 barrels,[32] 12.33 barrels and 3 barrels. The average initial gain of the fourteen treatments was 11.5 barrels a day, with no evidence to show how long this gain was sustained. Some of the initial gains that resulted from the use of the Grebe-Sanford process are set forth at pages 16 and 17, *supra*.

Inhibited acid presumably attacks limestone the same as does raw acid and we have always conceded this. Therefore, the difference in results must lie largely or wholly in the relative concentration of the acid and the manner of its introduction. Frasch used far more acid than did

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(31) The trade journal article which states that the gain of 3 barrels a day in the first well was permanent was written only two months after the treatment, so nobody knows how permanent it was. (R. 1653-4.) This is in no way comparable with average proven gains over five years from the Grebe-Sanford process.

(32) This well before treatment rapidly fell off from 60 barrels to 2 barrels production, doubtless indicating that the pores in the rock close to the well hole were plugged up. The acid opened these pores and produced a big change. This is an unusual condition, but of course the gain is figured in the above average. (R. 1662.)

Grebe and Sanford, so that one would naturally expect his increases in yield to have been greater than theirs. Yet his gains were far less. The only reasonable conclusion to draw is that the raw concentrated acid which Frasch used did much less useful work than the dilute inhibited acid used by Grebe and Sanford.

To attempt to account definitely for the failure of the Frasch raw concentrated acid process and the success of the Grebe-Sanford process would be largely speculation. The operations occur far underground, beyond the sight of man and under pressures of several hundred pounds per square inch. The results show there is a difference. Frasch used a violently reactive acid which he introduced slowly, so that most of its work was necessarily in or near the well hole. Grebe and Sanford used acid which because of its dilution acted on the rock comparatively slowly, and because it was inhibited and harmless to metal they could and did force it through the regular well tubing far into the rock comparatively fast, so that it did a large amount of its work at a distance from the well hole. Perhaps this explains the difference. In any event, the ultimate fact is clear—the Frasch concentrated raw acid process was a complete commercial failure, while the Grebe and Sanford dilute acid process was a brilliant success.

We may well wonder why Frasch and Van Dyke did not use an inhibitor and the regular pump tubing, and thus rid themselves of a major difficulty in making their treatments. However, the history of technical development very often shows that the ablest men sometimes overlook means of which they might easily have availed themselves had they happened to think of them. Furthermore, there is nothing in the record to warrant an assumption that Frasch's results in increased yields would have been benefited by the use of an inhibitor in the concentrated acid used in his experiments. Frasch's over-all results were

so poor as not to encourage anyone to revive his abandoned scheme. Despite its vastly increased convenience and simplicity of treatment, due to the use of dilute inhibited acid, the Grebe and Sanford process might have failed commercially had its results been as poor as Frasch's and as costly in acid.

From this standpoint, even an average of initial gains is deceptive, because business men are not willing to gamble on the mere possibility of success from an expensive operation. Taking the least successful half of Frasch's 14 tests on producing wells, we find the initial per diem gains ran 0, 0, 3, 3, 5, 7 and 8½, or an average of about 3.8 barrels. Considering the very large amount of concentrated acid Frasch used, those seven operations were undoubtedly losing ventures. When a process is so uncertain that half its operations result in losses, commercial success is out of the question, certainly unless the other half of the operations show such large and abundantly compensating advantages as to excite the gambling instinct.

Again let us consider the results obtained for one customer, The Ohio Oil Company, four of whose wells were treated. As previously explained, one of its wells pumped 35 barrels after the treatment, whereas it flowed 5 barrels before. The other three gained 3, 7 and 0 barrels respectively, average 3½ barrels. Even giving Frasch credit for the 30-barrel gain, no oil producer would go further with a process which in three out of four tests gave such poor results at such high cost. If the results obtained in Frasch's two best wells could have been dependably duplicated, his process might have succeeded, but even those results were insignificant compared to the increases which Grebe and Sanford obtained in their very early work.

It cannot be asserted with reason that it would pay to revive the Frasch concentrated acid process as he used it. Nobody has again tried it, and since respondent contends

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this is an anticipating process it certainly ought to have produced evidence tending to show that such a process could have succeeded.

The foregoing comparisons have been based upon Frasch's actual operations, and to a large extent on the early operations of the Grebe and Sanford process, where comparatively small amounts of acid were employed. As the success of the Grebe and Sanford process became established and well known, larger and larger volumes of dilute acid were used to reach further out into the limestone and open up more oil for recovery. Eventually, at least in some cases, the Grebe and Sanford process used volumes of dilute acid quite comparable with the volumes of concentrated acid used by Frasch. The operations and results of the two processes when practiced in that way deserve a brief additional consideration. Assuming that both processes start with the same amount of concentrated acid, Grebe and Sanford dilute their charge to twice the volume of Frasch's charge and it therefore saturates twice as much rock. Furthermore, because of the dilution it reacts less violently, that is more slowly, and therefore can preserve a higher percentage of its reactive capacity while it is being forced through the minute pores of the rock. Frasch's charge not only would saturate much less of the rock, but in all probability would do a higher percentage of its work close to the well hole. Finally, Frasch introduced his acid slowly while Grebe and Sanford use pressure to force their acid into the rock comparatively quickly, having developed an acid pump in connection with their earlier work in acidizing brine wells. (R. 1410.) Briefly, Grebe and Sanford with their dilute acid tend to erode a thin layer from the pores in a large volume of rock, while Frasch takes a comparatively thick layer from the pores in a much smaller volume of rock. Since the desired operation

is to facilitate the flow of oil from a large volume of rock into the well hole, it is evidently far better to attack the larger area of rock for any given expenditure of acid.

Thus, entirely aside from the convenience, simplicity and low cost of introducing the Grebe and Sanford charge, due primarily to the use of an inhibitor, their dilute acid process has great economic advantages over the use of equal amounts of active acid in a concentrated solution.

Claim 8 of the Grebe-Sanford patent covers their preferred operation. This claim plainly brings out the three points in which their process differs from the Frasch process, *i.e.*, (1) the use of dilute acid, (2) the addition of an inhibitor, and (3) the introduction of the charge through the regular pump tubing which is already in place in the well. This is the process used by the petitioner and its licensees and also by the respondent, it is the best process, and it is the process which created commercial success.

Undoubtedly, when their application was filed, and during its prosecution, Grebe and Sanford were interested primarily in covering their best process which is practically innocuous to the steel in the well structure. In retrospect, we see now that they might well have insisted upon and obtained a claim similar to claim 8, but not limited to the use of an inhibitor.[33] Such a claim would have covered an entirely novel process and one which should give highly beneficial results as compared with Frasch's failure, although not nearly as useful as the process they claimed and use. However, the fact that Grebe and Sanford did

[33] The chief element of novelty in the ore flotation process was the small amount of oil used, also it differed from prior processes in simplicity of operation. *Minerals Separation vs. Hyde*, 242 U. S. 261; *Minerals Separation vs. Butte, etc.*, 250 U. S. 336. In sustaining the patent the court, in the first of these cases, stated: "The simplicity of the operation, as compared with the prior attempts, is startling. * * * yet the investigations preceding were so interesting that this final step was not a long one and the patent must be confined to the results obtained by the use of oil within the proportions often described in the testimony and in the claims of the patent as 'critical proportions' amounting to a fraction of one per cent on the ore, * * *."

not cover all their novelty does not make the unclaimed part of their disclosure prior art to be used against them.

POINT II. THE OPERATIONS OF OIL MAKERS COMPANY AND CHEMICAL PROCESS COMPANY ARE NEITHER PRIOR ART NOR THE FRASCH PROCESS

The Oil Makers Company treated its first well in July, 1932, after its officers knew about the Grebe-Sanford treatments. (R. 1214.) Chemical Process Company started its operations still later, having learned of Oil Makers' operations. (R. 1003.) Therefore, anything those companies did was not a prior use, and evidence regarding their operations can be relevant only on the theory that they were using the old Frasch process and that their operations demonstrate the practicability and success of that process.[30]

Both companies used approximately 15% acid, which they ran into the well through the regular pump tube. Oil Makers at first used dilute acid without an inhibitor, which caused so much damage to well equipment that it soon changed to the more expensive inhibited acid and thus became an infringer. (*Supra*, pp. 19, 20.)

Insofar as the operations of Chemical Process Company are concerned, a single interested witness, the vice president of the company, testified that uninhibited acid was used in a large proportion of its treatments. No samples of its acid nor any analysis thereof was produced, but there is convincing proof, with introduction of samples, that the company surreptitiously inhibits its acid by placing rolls of sheet lead in its delivery tanks so that the in-

[30] A single deposition was offered by defendant to prove the operations of Chemical Process Company. This was objected to as irrelevant and admitted over the objection on the ground that it was the old Frasch process. (R. 1007.)

hibitors, lead and copper chlorides, are present in the acid when run into the well, just as they are in respondent's operations which both courts held to infringe.

Oil Makers caused so much damage to the well equipment when they used raw 15% acid that, despite the increased oil recovery of the wells treated, they were obliged to change to an inhibited commercial acid known as Duclean No. 2 and marketed by Grasselli Chemical Company. Undoubtedly, there was a great deal more damage done than was actually ascertained. Damage would only be discovered and complaint made when the well tubing was so eroded as to leak, fall apart at the joints, or otherwise demonstrate that it had been injured. In many cases the well tubing could be seriously damaged without giving any immediate sign that it had been impaired, but however that may be, the damage was admittedly sufficient to force the Oil Makers Company to change to directly infringing operations.

If it be assumed that Chemical Process Company did use uninhibited acid, the success or failure of its operations cannot be material, since it was not Frasch, nor was it a prior art process. To be the Frasch process, the only prior art suggestion to treat the producing formation with acid, the process must have employed concentrated acid introduced through a special acid supply pipe. Had such a special supply pipe not been used far more damage to the well equipment would have resulted than was caused by Oil Makers during the short period when it used dilute uninhibited acid. No sane operator would dream of putting concentrated acid through many hundreds of feet of valuable unprotected steel tubing. The result would be not only ruin of the tubing, but the expenditure of a large part of the acid strength or it and on the walls of the well hole instead of within the producing formation, with no assur-

ance of better results in increased yields than those obtained by Frasch.

The Court of Appeals laid great stress on the operations of the Chemical Process Company, stating that it has, since 1932, "successfully acidized 15,000 wells serving most of the major oil companies, and using in almost all instances raw acid. *Thus it has been employing the Frasch method.*"

This demonstrates a complete misunderstanding of the admitted facts and also raises an immaterial and improper issue. This company diluted 18° Baumé hydrochloric acid with equal quantities of water and introduced the mixture through the pump tubing (R. 1003). It admittedly used inhibited acid early in its practice. (R. 1004.) It claims to have abandoned inhibited acid while the Tenth Circuit case was on appeal and before the decision holding the patent in suit valid. Even if that were true, its operations can have no bearing on the present case. They would then have been the same as the first operations of the Oil Makers, *i.e.*, with *dilute* raw acid pumped *down the well tubing* and expelled by pump pressure. That was not the Frasch process, but a new process developed in the light of the Grebe-Sanford invention, in an effort to obtain some of the benefits of their great discovery without using enough to infringe. It is utterly immaterial that something different from what Grebe and Sanford claimed would be measurably successful, unless that process were really prior art, which it clearly was not. These operations, therefore, were not the Frasch operations, and they give no light whatever on whether the Frasch process could have succeeded.

However, the operations of Chemical Process Company are open to another and entirely different attack. Since the patent in suit was held valid in the Tenth Circuit, Chemical Process Company has been using a means to inhibit its acid which is substantially the same as that used by respondent and held by both courts to be an infringement if the patent in suit is valid.

Whereas the Oil Makers Company transported its raw acid to the wells in wooden tanks (because it was warned by the manufacturer of the acid that the acid would destroy a steel tank) and thus got its acid in honestly raw condition to the wells, respondent and Chemical Process Company use steel tanks for transporting their acid and have adopted subtly ingenious methods of inhibiting the acid before it is run into the oil well tubing. (R. 116.)

Respondent rigged up an electric battery system in which lead plates in the tank were one pole and the steel wall of the tank was the other pole, and thus considerably reduced the attack of the acid on the transportation tanks. (*Infra*, pp. 64, 65.) However, at the same time and as an incident to this method of protecting its tanks, there is dissolved in the acid enough copper and lead greatly to reduce its corrosiveness of iron and steel. Both the District Court and the Circuit Court of Appeals held that this alteration of the acid by respondent (which due to the ingenious nature thereof was proved only with great difficulty by evidence which occupies fully half of the present record) was such that its use in treating oil wells constitutes infringement of the patent in suit, if the patent is valid. Thus, in respondent's case, its loud protestations that it uses no inhibitor were unhesitatingly overruled.

The only testimony in the record to the effect that Chemical Process Company uses no inhibitor in its acid is the uncorroborated statement of a single interested witness, the vice president of that company, which certainly ought to be given no greater weight than respondent's similar insistence that it uses no inhibitor. (R. 1003-6.)

While the whole subject of the Chemical Process Company's operations should never have been admitted in evi-

dence or considered at all, because the process obviously is not prior art and is not the Frasch acid process, yet when it was made an issue petitioner proved that rolls of sheet lead are present in the steel transportation tanks used by Chemical Process Company to transport its acid from the storage tank to the wells. (R. 1301-6.) Thus, Chemical Process Company's acid was proven, by the presence of lead sheets in its steel tanks, to be secretly and subtly inhibited just as is respondent's, and we cannot understand why the Court of Appeals should accept the assertions in a single deposition, and that of an officer of the company, that it does not use an inhibiter when it squarely overruled precisely the same assertion by respondent.

Both respondent and Chemical Process Company have sheet lead in their transportation tanks. The presence of the lead sheets in its tanks was found to cause inhibition of respondent's acid (R. 592) and it must also in the Chemical Process case. In respondent's case, we proved the inhibition beyond the possibility of doubt, because that was a direct issue in the litigation. We should not be punished for failing to offer similar, equally involved proofs in the case of another infringer, who claims no more than respondent did, especially when such proofs would not have related to anything that was done prior to the date of the Grebe-Sanford invention.

Of course, the shortest and best answer to the Chemical Process evidence is that since it is a dilute acid process applied through the regular well tubing and not the Frasch process, and since it does not follow the prior art at all, it has no place in the case. Any measure of success the Chemical Process Company may have had is not, as the Court of Appeals mistakenly assumed, a demonstration of the Frasch process.

POINT III. THE GYPSY OIL COMPANY EXPERIMENTS IN SANDSTONE WELLS

The court in the Tenth Circuit was undoubtedly right in its conclusions as to the Gypsy operations when it stated that they constituted nothing more than an abandoned experiment, and were not an anticipation, even if proven to be successful. The most that can be claimed for this experiment, based on the reports and correspondence, is that it was technically operative to remove scale from the well wall and equipment, but without increasing production and at such prohibitive cost (R. 1685) as to make the process a commercial failure, with the incidental undesirable result of releasing quantities of loose sand which accumulated in the well hole and had to be removed before the well could be pumped. (R. 1682-3, 1677.)

The District Court found that Gypsy used inhibited concentrated hydrochloric acid for removing scale from three of its wells in the Glenpool sandstone field during 1928 and 1929. (R. 1488.) There is some evidence that Gypsy made similar experiments in other wells, using uninhibited acid. Its last effort to remove gyp with inhibited acid was in September, 1929, and its last effort to use raw acid for that purpose was in March, 1931.

This scale removal experiment, even though technically operative to remove scale, did not and never would have taught anyone to pump large volumes of inhibited dilute hydrochloric acid down through the pump tubing and out into the rock formation in limestone wells for the purpose of increasing production.

After a lapse of nearly two years after the Gypsy Glenpool experiments, during which it made no effort to revive this scale removal experiment, Gypsy learned of the success of the Grebe-Sanford process in increasing the production from limestone wells and immediately adopted

it, as did everyone else for such wells, and has used it extensively ever since.

Everybody who produced oil from limestone wells needed the Grebe and Sanford process. Gypsy's technical oil men and geologists, dozens of them, knew all they ever learned about the Gypsy process as early as November 12, 1928, when the first Gypsy test was made, and Gypsy needed the Grebe and Sanford process just as badly then as it ever needed it later, yet for four and one-half years that knowledge did not lead it to go into its closely adjacent limestone fields with the Grebe and Sanford process or with anything even remotely resembling it. On the contrary, it made no attempt to increase the production of its limestone wells by acidizing them until it learned of the success of the Grebe-Sanford process early in 1933, after which it used that process extensively through the employment of petitioner's licensees and also in treating its own wells. (R. 1088, 1090, 1704.)

The theoretical assumption that Gypsy's scale removal experiment in 1928 taught its skilled geologists and production engineers how to increase the production of their limestone wells by the Grebe-Sanford process is absolutely irreconcilable with the proven practical facts that Gypsy waited over four years before having any of its numerous limestone wells treated with the Grebe-Sanford process and applied that process to nearly one hundred other wells within a few months thereafter. (R. 1088, 1090.)

It is simply absurd to argue that if the technically operative experiment in scale removal in Glenpool field really taught the present process, Gypsy would have waited over four years before putting that knowledge to work.

If, as the Court of Appeals for the Sixth Circuit found, the Gypsy concentrated acid scale removal process *anticipated* the patent in suit, *i.e.*, taught the same thing, Gypsy

certainly would have resorted to its use immediately instead of dropping it completely, even for its limited purpose, and later turning to petitioner's licensee to provide it with the vast increases in yield which it obtained from the use of the Grebe-Sanford process.

The first well to which the Grebe and Sanford process was applied for Gypsy by plaintiff's licensee showed a gain of 555 barrels per day, and among the first few wells treated were gains of 248 barrels and 95 barrels. (R. 1104.)

The court in the Tenth Circuit was entirely right in finding that the Gypsy process was nothing more than an abandoned experiment and that it would not have anticipated even if fully established. Abandonment is a question of fact, and the duration of abandonment is only evidentiary. From March, 1931, Gypsy dropped all efforts at scale removal by the use of acid, either inhibited or uninhibited. (R. 1088.) Thereafter it tried various other means for removing scale and in April, 1932, it was using a mechanical scraper for this purpose and recommending the extension of such use to other wells. (R. 1693.) In February, 1933, nearly two years after it had completely dropped the acid treatment for scale removal in sandstone wells, it adopted, with justified enthusiasm, Grebe and Sanford's process in its limestone wells, not to descale tubing but to increase their production, which it continues to use.

These two processes are on their face widely different, designed for different purposes and deal with the acid in different ways. One failed commercially, even for its very minor intended purpose. The other became an overwhelming success. In retrospect, the differences may not seem great, but it is absurd to assert that in any sense the Gypsy process is a true anticipation. Its failure and abandonment should disqualify it as prior art, but the statement of the Court of Appeals that the process *anticipates* simply shows an egregious misunderstanding of the facts.

The Gypsy process does not even approximate claim 8. It is an accepted axiom of patent law that what infringes if later anticipates if earlier and *vice versa*. The claim calls for dilute acid, where Gypsy used concentrated. The claim calls for introducing the acid through the pump tubing and forcing it by pressure from there into the rock. Gypsy did nothing of the kind, but, on the contrary, sought to avoid any penetration of the acid into the sandstone rock because it would eat out the soluble binder and deposit loose sand in the well hole. Gypsy simply partly filled the well casing and tubing with the body of acid and held it there by vacuum and let it react. There plainly is no *anticipation*.

These abortive experiments ought not to be held relevant as prior art. They never taught anybody anything, and never would have been heard of again except that someone wanted to make capital out of them in litigation. But even if treated as prior art they taught nothing that everybody didn't know already. It was known that hydrochloric acid would eat limestone. It was known that inhibited hydrochloric acid would not eat iron, but would eat calcium carbonate. It was known that wells had tubing in them, and it was known that a large proportion of every oil deposit remained underground after all known methods of recovering it were exhausted. Every oil producer wanted to recover more oil, yet it remained for Grebe and Sanford to combine these separate elements of knowledge to form a single operative process which added immeasurably to our national wealth, to a very great extent solved an ancient and theretofore unsolved problem, and which today is used to treat wells in practically every limestone oil-producing field in this country.

Nothing Gypsy did in its efforts to remove scale from the equipment in its sandstone wells with small quantities of concentrated hydrochloric acid remotely suggested the

wisdom of introducing into the producing formation large volumes of dilute hydrochloric acid to increase the production of limestone walls. The problems and results were entirely different. Gypsy wanted to work entirely within the well, and it properly used concentrated acid to get the quickest and most localized action. The acid being neutralized by reaction with the gyp scale before it could reach the tubing, no inhibitor was necessary and none was used in two-thirds of the treatments. Grebe and Sanford wanted to work as far from the well as possible, to open up the pores in the largest volume of limestone. The Gypsy Company introduced just enough acid to fill the gyp covered pipe and very carefully held it there, where it exhausted itself on the gyp, whereas Grebe and Sanford use large quantities of dilute acid which they expel from the well tube into the bore of the well and out into the rock to act, not on materials within the well, but on the rock pores. The processes are entirely different, and are for entirely different purposes.

CRITERIA OF INVENTION

This court in 1851 declared that to be valid a patent must display not only novelty, but novelty of a kind beyond the skill and ingenuity of "an ordinary mechanic acquainted with the business" (*Hotchkiss vs. Greenwood*, 11 How., 52 U. S. 248, 267). In applying this rule it presently appeared that while most cases require a retrospective comparison of the inherent ingenuity of the patentee's concept with the ingenuity expected of the hypothetical skilled mechanic, yet a comparatively small proportion of the cases require only objective historical examination.

When a serious and recognized need exists for a long time and the means to fulfill the need are always available, the "ordinary mechanic acquainted with the business"

would certainly solve the problem if it were within his capacity. The continued failure of a whole industry to solve a problem conclusively proves that the ordinary mechanic cannot solve it. The uncertain test of "retrospective simplicity" always gives way to the objective test of history when that is available.

Retrospective comparison often leads to special unfairness when made by a brilliant jurist who naturally postulates an ordinary mechanic possessed of acumen equal to his own, a clearly false hypothesis. Whole industries sometimes get into such mental ruts that they miss the simplest things, completely justifying this Court's reference to "the common history of important inventions, the simplicity of which seems to the ordinary observer to preclude the possibility of their involving an exercise of the inventive faculty" (*Carnegie vs. Cambria*, 183 U. S. 403, 429).

In view of the recent full consideration of the long-felt-want rule in *Goodyear Tire and Rubber Co. vs. Ray-O-Vac Co.*, 321 U. S. 275, a complete argument of the point seems unnecessary. Other outstanding cases in this Court in which patents were sustained under the long-felt-want rule are as follows:

Smith vs. Goodyear Vulcanite Co., 93 U. S. 486, the Hard Rubber Toothplate Case.

Barbed Wire Patent Case, 143 U. S. 275.

Krementz vs. S. Cottle Co., 148 U. S. 556, involving the one-piece collar button.

Carnegie vs. Cambria, 185 U. S. 403, involving the dominant pool in which by blending successive charges of molten pig iron from blast furnaces, sufficient uniformity of composition was obtained for Bessemer Converters.

Smith vs. Snow, 294 U. S. 1, involving the use of a circulating fan to get uniform temperature in an incubator.

The inventions upheld in these cases certainly could not have stood the misleading test of retrospective simplicity for they were all extremely simple and in at least two of them (*The Barbed Wire Case* and *Cargenie vs. Cambria*) this Court said it was strange that the invention had not been made earlier.

Furthermore, this Court in *Paramount vs. Tri-Ergon*, 314 U. S. 84, 94, although holding the patent void for want of invention, plainly suggested that had the facts justified applying the long-felt-want rule, the result would have been different.

The same position was taken in the concurring opinion of Mr. Chief Justice Stone and Mr. Justice Frankfurter in *Cuno Engineering Company vs. Automatic Devices Company*, 314 U. S. 84, which restates the long-felt-want rule and distinguishes from it on the facts.

In *Goodyear Tire and Rubber Company vs. Ray-O-Vac Company*, 321 U. S. 275, an extremely simple device was held patentable under the long-felt-want rule. This case is so recent that we only remind the Court that the invention was a dry battery rendered "leak-proof" by the use of a steel shell insulated from the electrodes and tightly embracing the ends of the cell.

Finally, in *Universal Oil Products Company vs. Globe Oil and Refining Company*, 322 U. S. . . . , the Court seems unanimously to accept the long-felt-want rule when it says (p. 1117):

> "Retrospective simplicity is often a misleading test of invention where it appears that the patentee's conception in fact solved a recognized problem that had baffled the contemporary art."

The opinion correctly differentiates the Egloff patent on its facts from the rule here invoked.

The House of Lords (The Lord Chancellor Viscount Simon, Lord Russell of Killowen, Lord Macmillan, Lord

Romer, and Lord Wright) recently took the same position as that of this Court and on the same grounds of logic. It said in *Non-Drip Pressure Coy., Ltd. vs Stronger's Ltd.*, 60 R. P. C. 135 (Opinion by Lord Russell of Killowen):

> "It is always pertinent to ask, as to the article which is alleged to have been a mere workshop improvement, and to have involved no inventive step: Has it been a commercial success? Has it supplied a want? Some language used by Tomlin J. in the case of *Samuel Parkes & Coy., Ltd., vs. Cockey Bros., Ltd.** may be cited as apposite: 'Nobody has told me, and I do not suppose that anybody ever will tell me, what is the precise characteristic or quality the presence of which distinguishes invention from workshop improvement. * * * *The truth is that when once it has been found that the problem has waited solution for many years, and that the device is in fact novel and superior to what had gone before, and used in preference to alternative devices, it is practically impossible to say that there is not present the scintilla of invention necessary to support the patent.*' As to the commercial success of the plaintiffs, there can, in my opinion, be no doubt. In 1935, 450 measures were sold, in 1936, 7,996, in 1937, 16,700, and in 1938, 18,400. In the war years the sales naturally fell off, but the success of the machine was immediate and great. That there was a need for such a machine was clear from the defects in those already on the market. Nor should it be forgotten that as far back as the year 1908 Newland was trying to solve the problem of producing a machine which would deliver measured quantities of liquid without requiring one hand of the operator to be left free to operate the valves. He failed to produce a practicable or marketable machine. It is not until 27 years have elapsed that the successful machine is forthcoming, which achieves the object at which Newland aimed. *If during that long period it only re-*

*46 R. P. C. 241, 246.

> *quired a workman to be told to adapt Newland to upward pressure, for him to produce a machine as claimed in the plaintiff's patent, it is hard to understand why the production was so long delayed. There can, I think, be only one explanation, and it is that before such a machine could be produced an inventive step had to be taken,* and that those who took out the plaintiffs' patent were the first to take it."

Lord Romer added:

> "Now that the idea has been carried into effect it is easy to take the steps one by one and say that individually they involve no inventive step. For it is well settled that this is not a legitimate method of approach."

While the objective historical test leads to sustaining some patents which the test of retrospective simplicity would strike down, it is actually a more severe test than that commonly applied. Under the broad rule a concept is inventive if beyond the expected skill of the "ordinary mechanic acquainted with the business." When this rule is applied by the method of retrospective comparison, the measuring rule is not the skill of the most intelligent mechanic, but of the ordinary mechanic, just as in negligence cases the measuring rule is not the care of the most careful man, but that of the ordinarily prudent man.

When, however, history justifies the application of the long-felt-want rule, the concept is shown to be one which by the test of time is beyond the capacity of the whole industry, including not only its ordinary mechanics, but also its trained research men, its inventors, and its men of genius, if there were any in the industry. The present record is replete with abortive efforts by many men to get more oil out of the ground. Thirty-five years elapsed between Frasch's failure and the Grebe and Sanford success and during that time scores of good men worked on the prob-

lem. The facts show that the retrospective test is inapplicable.

Of course, in determining whether to apply the long-felt-want rule this Court must re-examine the facts, since on this point there is a diversity of view between two Circuit Courts of Appeals (*Universal Oil Products Co. vs. Globe Oil and Refining Co.*, 322 U. S. ....; *Sanitary Refrigerator Co. vs Winters*, 280 U. S. 30, 35-6). On the facts, however, there is little room for dispute when the evidence is carefully examined. The Frasch process was so poor that it was completely abandoned in 1896 and has never again been revived. The Grebe and Sanford process, differing in several respects, successfully accomplished the result Frasch vainly sought and was and is an overwhelming success.

One part of the factual basis for applying the long-felt-want rule usually is direct evidence as to the existence of the problem. That appears here from the testimony of experts concerning the oil left unrecovered by prior methods and the history of many abortive efforts to recover it.

It must also be proved that the invention before the court solves the problem. That may be shown either by direct evidence of improved results or circumstantially by widespread acceptance of the invention, or both.

When an invention can be brought within the rule by direct proof that the problem has been solved there need be no proof of widespread adoption, since a patentee might prefer to keep the invention for his own limited use and reap the profits resulting from reduced cost. Indeed, in *Carnegie vs. Cambria* the patentee for some years kept the invention within its own plants, and much of the extensive use arose from the large size of the plaintiff company. Yet the direct evidence concerning the existence of

the problem and its satisfactory solution gave adequate factual basis for applying the historical rule.

When, however, the invention is of a kind or is so handled, as it has been here, that it is widely and rapidly accepted, this fact circumstantially proves both the continuing existence of the need and its satisfaction by the invention. While the present record contains ample direct evidence of the existence of a problem and its solution by the Grebe and Sanford method, the immediate and universal adoption of the method in all limestone fields supplies adequate circumstantial evidence, independent of the direct proof, to call for the application of the objective historical test rather than the uncertain test of retrospective simplicity.

The application of these long-established principles to the facts here requires a reversal of the decree of invalidity.

BRIEF FOR CROSS-RESPONDENT ON THE QUESTION OF INFRINGEMENT

The cross-petition raises the question of infringement. Voluminous proofs were taken on this subject, including the testimony of two experts for each party, which comprises approximately one-half of the printed record in this case. The trial court held that defendant had appropriated the process of the Grebe and Sanford patent No. 1,877,504 if that patent were valid,[35] and the Court of Appeals con-

two courts in this case and the fact that there is no conflicting opinion by any other court, it is not believed that the question of infringement is open here.

Continental Paper Bag Co. vs. Eastern Paper Bag Co., 210 U. S. 405, 416, 422; 28 S. Ct. 748, 750, 752.

Adamson vs. Gilliland, 242 U. S. 350; 37 S. Ct. 169.

Williams Manufacturing Co. vs. United Shoe Machinery Corp., 316 U. S. 364, 367; 62 S. Ct. 1179, 1181.

Goodyear Tire & Rubber Co. vs. Ray-O-Vac, 321 U. S. 275; 64 S. Ct. 493, 594.

STATEMENT OF THE CASE ON THE CROSS-PETITION

The cross-petitioner, Halliburton Oil Well Cementing Company, was organized in 1924 primarily to cement and service oil wells. Erle P. Halliburton organized it, has always been its president and at all times has owned or controlled a majority of its stock. (R. 240.) Before its

curred in this finding,[36] In view of this concurrence by the

[35] Finding 84 (R. 1490) and conclusion of law 2 (R. 1942). This fact finding follows in substance the language of patent claim 8.

[36] R. 2054.

organization he was thoroughly familiar with oil production, had worked in the oil fields of California, Texas, Oklahoma, Arkansas and Louisiana, and had owned interests in oil wells. Later, he organized and controlled two oil producing companies—Steen Drilling, Inc., and Erle P. Halliburton, Inc. (R. 241-2.)

Asked whether prior to 1932 he had known of efforts to increase production of limestone wells, Halliburton stated that he had redrilled wells, lots of them, prior to that time, that he knew of shooting methods where a lime formation was shot with nitroglycerine to break the formation, and that he had used acid in a well either in December, 1919, or January, 1920.[37] He also had known of flood-paraffin. (R. 243-5.)

In March, 1934, Steen Drilling, Inc. employed Dowell, Inc., to use the Grebe-Sanford process on two limestone wells in Louisiana (R. 1632), and in April, 1934, Steen Drilling, Inc., and Erle P. Halliburton, Inc., employed Dowell to acidize by the same process ten or more limestone wells in Louisiana, Oklahoma, Kansas, Texas or New Mexico. (R. 1635.)[38]

After thus learning about the Grebe-Sanford process the cross-petitioner branched out into the business of acidizing wells to increase production, using dilute hydrochloric acid introduced through the regular pump tube.

[37] This use of acid, according to respondent's counsel, "related to getting out drill pipe or tools that had been stuck in a well and using the acid to cut that limestone, * * *."

ing and vacuum methods, and of the use of heat to dissolve

[38] Exhibits 38, 40, 43 and 46 (R. 1639-40) are purchase orders, dated March, April and May, 1934, issued to Dowell by Steen Drilling, Inc., and Erle P. Halliburton, Inc., for 1,000-gallon, 1,500-gallon and 2,000-gallon acid treatments for specified wells, and Exhibits 52, 54, 57, 59, 62, 64 and 66 (R. 1641-48) are receipts for acid treatments made by Dowell for Steen Drilling, Inc., or Erle P. Halliburton, Inc., dated in July, August, September, October, November and December, 1934. On November 9, 1934, Erle P. Halliburton, Inc., purchased from Dowell 1,000 gallons of "Dowell X," being the trade-name for Dowell's inhibited hydrochloric acid used in practicing the Grebe-Sanford process. (Exhibit 27, R. 1631.)

On the first few wells it used no inhibitor, but soon changed to inhibited acid, as Oil Makers Company had done in 1932. (R. 256.) The witness Hoisington, who had charge of the early acidizing operations of the cross-petitioner, testified (R. 256):

> "* * * During the time that I was in charge in Kansas I used inhibited acid after, I think, the second or third job which was about January and February, 1935. The inhibiters used, as I recall, were Nep 22 and Murodine. * * *
>
> "We used these inhibitors up until the Circuit Court of Appeals handed down the decision in Denver, in the case of *The Dow Chemical Company vs. Williams Brothers Well Treating Corporation*, which was about 1936. I used the inhibitors, Nep and Murodine, in my district in Kansas from early in 1935 up to 1936, and those are the only inhibitors I recall using during that period."

Instead of merely dropping the use of the inhibitor and continuing its operations with dilute raw acid, as it claims Chemical Process Company was then doing with great success, the cross-petitioner entirely discontinued its acidizing business shortly after the decision of the Circuit Court of Appeals in the *Williams* case in January of 1936 (R. 262-3), and did not resume the acidizing of wells until it had devised the method of subtly inhibiting its acid by inserting sheet lead in its transportation tanks, which both courts below held to infringe. This method was first described in a booklet entitled "Howco Method of Protecting Tubing and Casing Against Corrosion While Acidizing a Well," published in March, 1937. (R. 587-90, PX-186.) In this Howco method respondent brazes a number of lead sheets to the inside bottom of the steel tanks in which it transports its hydrochloric acid from the acid storage station to the wells. (R. 261 and Exhibit 71, p. 1649.)

When the acid covers these lead plates a battery system is set up one effect of which is to create in the acid minute quantities of copper and lead chlorides. These are effective inhibitors when present in these proportions and it was because of their presence in the acid when used in the wells that the lower courts held the cross-petitioner's process to infringe. Tests of the samples of the storage and well-treating acids employed by cross-petitioner disclosed that these inhibitors were formed in the acid after it left the storage tanks.

At the trial the following steps were proven and held to constitute infringement:

1. **Cross-Petitioner Uses Dilute Acid**

Cross-petitioner purchases raw 30% commercial hydrochloric acid and stores it in wooden tanks at its treating station at Mt. Pleasant, Michigan. Before using it to acidize oil wells it is diluted to about 15% strength by the addition of water. (R. 307, 314, 315, 320, 326, 328, 342, 345.)

2. **Cross-Petitioner's Treating Acid Sampled at the Wells Was Much Less Corrosive to Iron Than Was Its Diluted Storage Tank Acid**

This point was proved by Dr. Bartell, head of the department of chemistry at the University of Michigan. Samples of cross-petitioner's storage and treating acids were delivered to and tested by him to determine to what extent they were inhibited. He immersed strips of strap iron of uniform size and of oil well tubing of uniform size in 50 c.c. of the storage and treating acids for 16 hours, and measured the loss in weight of the strips. The results are tabulated in Bartell's Tables I to VIII, Exhibits 154 to 159. (R. 1705-10.)

In these tables the results are stated as "% Reduction in Corrosiveness" of the acids as compared with chemically pure hydrochloric acid which was taken as being 100% corrosive. The tables show an average reduction in the corrosiveness of the treating acid of about 52% with strap iron test pieces (R. 335) and about 42% with oil well tubing test pieces (R. 337-8), whereas the average reduction in corrosiveness of cross-petitioner's storage acid, which had not been in contact with the lead of its transport tanks, was only about 8.3% when tested with pieces of strap iron and about 10% when tested with pieces of oil well tubing. (R. 1709-10.)

Analyses showed that cross-petitioner's treating acids contained much more dissolved copper, lead and iron than did this storage acid.[39] Stated in parts per million, the treating acids contained an average of 3.8 of copper, 302 of lead and 354 of iron, whereas the corresponding figures for the storage acids, after dilution, were 0.46, 4.7 and 8.9.

Synthetic acid solutions were made up by adding to chemically pure HCl various amounts of lead, copper and iron, singly and in different combinations, and tests of these were made to show the effect of these additions in reducing the corrosiveness of the acid, that is, to show whether these metals, or some of them, as found in cross-petitioner's treating acid, are inhibitors. (R. 390-4; 398-406.)[40] In these tests the addition of copper alone in amounts of from 1 to 100 parts per million reduced the corrosiveness of the acid by from 20% to 40% and the reduction in corrosiveness was especially rapid when the amount of copper was increased from one part per million

[39] The amounts of these metals found to be present in the treating acid samples are shown in Exhibit 160 (R. 1711); the amounts found in the storage acids, before dilution, are shown in Exhibit 161 and after dilution to the strengths of the treating acids are shown in Exhibit 162 (R. 1712).

[40] The results of these tests are shown in Bartell's Table XVIII, Exhibit 166 (R. 1716-18).

to 3.5 p.p.m., 1 p.p.m. showing a reduction of 20% and 3.5 p.p.m. showing a reduction of 33%. Respondent's acid contained an average of 3.8 p.p.m. of copper.

The maximum effectiveness of the lead alone appeared at about 320 p.p.m., which caused a reduction in corrosiveness of 12%, whereas 160 p.p.m. caused a reduction of only 6%. 420 p.p.m. caused 13%, or only 1% more than 320 p.p.m. Respondent's acid contained an average of 302 p.p.m. of lead. Iron alone had little or no effect.

The combination of these metals most effective in reducing the corrosiveness of hydrochloric acid solutions was 3.5 p.p.m. of copper, 420 p.p.m. of lead and 440 p.p.m. of ferric iron, which closely approximates cross-petitioner's treating acid, which contained an average of 3.8 of copper, 302 of lead and 354 of iron. (Solution No. 68, R. 1718.)

In order to simulate the flowing motion of the acid in the well tubing during an acidizing treatment, Dr. Bartell ran tests with synthetic acid samples in which the acid was agitated, some of these tests being with 50 c.c. of acid and others with 300 c.c. (R. 407-8). The results showed that agitation further reduced the corrosiveness of the inhibited acid solutions and that increasing the relative volume of the acid still further reduced its corrosiveness, these effects being cumulative in the 300 c.c. tests. (R. 1719, Exhibit 167.)

The results of Dr. Bartell's various tests are accumulated and shown graphically on Plaintiff's Exhibit 170 (R. 1721), which is explained at R. pp. 428-431. The black horizontal lines indicate corrosiveness, the upper one showing chemically pure acid as 100% corrosive. The next six black lines show the corrosiveness of different solutions of Exhibit 166 (R. 1716). For example, solution No. 2 was 15.1% chemically pure acid plus 3.5 p.p.m. of copper, and the corrosiveness of 50 c.c. of the solution was 33% less than that of the unadulterated chemically pure acid. The

fourth black line from the bottom shows that agitation of 50 c.c. of the No. 2 solution made it 9% less corrosive than it was without agitation, and the last three black lines show the effect of both agitation and increased amounts of the solution. These last four black lines are based on Exhibit 167. (R. 1719.)

Dr. Bartell's findings on the inhibitive effect of small amounts of copper, lead and iron dissolved in hydrochloric acid were corroborated by Dr. Carl F. Prutton, who is in charge of the Chemistry and Chemical Engineering Departments of Case School of Applied Science. He made a series of tests in which one-inch sections of Oil Well Supply Company 1¼" oil well tubing were suspended *without agitation* in 1360 c.c. of chemically pure HCl to which had been added different small amounts of lead, copper and iron. (R. 501-5.) The results are shown in Exhibits 173-A to D (R. 1726-28). Seven series of tests were made, one using chemically pure acid and the others using similar acid to which the three metals, copper, lead and iron, had been added in different amounts. Tests of these six synthetic acid solutions showed reductions in corrosiveness of from 59.7% to 71.4%. Sample No. 3 is the one whose metal content was closest to the average of cross-petitioner's truck samples. It contained 3.72 p.p.m. of copper, 242 p.p.m. of lead and 473 p.p.m. of iron, and gave a reduction in corrosiveness of 70%.

Dr. Prutton also made a number of large scale tests in each of which he used approximately 200 gallons of commercial hydrochloric acid bought from Grasselli Chemical Company, and diluted to approximately 15% by adding water. This was run through 112 feet of 1¼" oil well tubing at the rate of one gallon per minute. In some runs the raw acid was used and in others small amounts of copper, lead and iron were added to the acid. The results of

these runs are shown in Exhibits 176 to 183. (R. 1734-41.)

Exhibits 176 to 179 show the results of four runs using the raw HCl reduced to 15% strength. The iron picked up by the acid in its passage through the tubing (due to corrosion) was 1043, 943, 919 and 791 grams, respectively, an average of 924 grams for the four runs. In the other four runs (Exhibits 180 to 183) small amounts of copper, lead and iron were added to the acid solutions in an effort to duplicate substantially the amounts of those metals found by Dr. Bartell in cross-petitioner's treating acid. The amounts of copper in the acid at the start of the four runs were respectively 2.78 p.p.m., 3.07 p.p.m., 3.71 p.p.m. and 3.8 p.p.m., and the lead contents were respectively 390, 316, 455 and 340 p.p.m. The iron taken up by the acid in these four runs was 238, 299.8, 195 and 101.4 grams, respectively, an average of 208.5 grams, as compared with an average of 924 grams on the four runs using commercial HCl without any addition of inhibitors. These tests are discussed at R. 510-32.

The results of these tests, computed by Dr. Prutton and expressed in grams of iron dissolved per hundred feet of tubing per hour of contact, show that the amount of iron dissolved off the tubing by the raw commercial acid was 264.5 grams as compared with 59.4 grams by the inhibited commercial acid. Hence, the inhibited acid was less than one-quarter as corrosive as the raw acid. (R. 517, 532.)[40]

Dr. Prutton's results fully confirm those of Dr. Bartell in demonstrating the effectiveness of lead and copper and

[40] These tests are explained by Dr. Prutton (R. 501-5) and the results of the tests are shown graphically in Exhibits 187 and 189 (R. 1752, 1754), the method being the same as explained in connection with Dr. Bartell's graph, Exhibit 170 (R. 1721). Exhibit 189 (R. 1754) shows the results of Dr. Prutton's seven sets of small scale tests, shown in tabular form in Exhibit 173-A (R. 1726), and Exhibit 187 (R. 1752) compares the average of his four large scale runs with raw commercial acid (R. 1734-37), which average is taken as showing 100% corrosiveness, with each of the four large scale runs in which he added copper, lead and iron to similar raw commercial acid.

the ineffectiveness of iron as inhibitors, and his tests further show that the reduction in corrosion due to the presence of inhibitors is considerably greater with actual oil well tubing and flowing acid than it is with the small test pieces and no agitation.

Cross-respondent based its proofs of infringement upon tests made on samples of the acid used by cross-petitioner in treating certain wells. Although portions of the same samples were given to cross-petitioner, it never offered any evidence based on these samples to contradict cross-respondent's proofs or for any other purpose. Thus, there is no evidence in the record to negative cross-respondent's proofs that such samples were hydrochloric acid of about 15% concentration and were so inhibited that their corrosiveness was reduced 42 to 70 per cent. (R. 1705.) Cross-petitioner readily could have made tests of the acid it was using by taking portions thereof from its own acid truck tanks, but this it never elected to do. (R. 874-875.)

While cross-petitioner contends that its acid is not inhibited, it never offered evidence of any tests of its acid to support its contention. Obviously, had cross-petitioner's acid not been inhibited, this could have been proven by simple tests.

3. Cross-Petitioner's Treating Acid Is Introduced Into the Well Through the Regular Pump Tubing

At the well being treated cross-petitioner connects its truck tank to the well tubing by means of a hose connection through which the acid, inhibited as above explained, is pumped from the truck tank into the well tubing and through it into the well. (R. 287-290.)

4. Pressure Is Applied to the Acid in the Pump Tubing

Cross-petitioner expels the acid from the tubing and forces it out into the producing formation by means of a

pressure pump which in the wells relied on to prove infringement created pressures up to 700 pounds per square inch at the head of the tubing. (R. 278, 1815, 1818 and 1820.)

5. **Withdrawal of the Spent Acid**

The spent acid is withdrawn from the well either by swabbing or as the well is put back on production. (R. 279-89.)

CROSS-PETITIONER'S PROCESS INFRINGES

Under many decisions of this court, a few of which we have cited at page 62, *supra*, the concurrent findings of the District Court and the Circuit Court of Appeals should settle the question of infringement, and preclude the necessity for further consideration thereof. The District Court found that cross-petitioner inhibits its acid "by the presence in the acid of dissolved lead and copper" and that it treats oil wells "by charging into the well tube, by means of a pump, an inhibited hydrochloric acid solution of about fifteen per cent concentration, expelling such acid solution into the base of the well to act upon the rock formation surrounding the well cavity, and withdrawing the spent acid." (Fact findings 83 and 84, R. 1490.) These findings are fully supported by the proofs and establish infringement of even the most limited of the claims in suit.

In concurring in the finding of infringement the Court of Appeals stated (R. 2054):

> "An acid solution of about fifteen per cent concentration is used by the appellee, and when the acid is inserted in the tubing of the well, the copper, lead and iron chlorides therein act to reduce corrosion from forty to sixty per cent. Although no chemical action is present between the hydrochloric acid and the arsenic compounds which are used by appellant as inhibitors (in the specific example of the patent), as

is the case in appellee's process, the District Court found, we think correctly, that appellee infringes if the patent is valid."

The average metal content of the samples of cross-petitioner's storage acid, diluted to the strength of its treating acid, was copper 0.46 parts per million, lead 4.7 p.p.m., and iron 8.9 p.p.m. (R. 1712, Exhibit 162), whereas in cross-petitioner's treating acid sampled at the wells these metals were increased to copper 3.8 p.p.m.; lead 302 p.p.m.; iron 354 p.p.m. (R. 1711.) Copper was thus increased more than eight-fold and lead more than seventy-fold. The average reduction in corrosiveness of cross-petitioner's treating acid, as compared with chemically pure acid, was 52%, while its storage acid was on the average only 8.3% less corrosive than the pure acid. (R. 1705, 1709.) These figures were obtained with 50 c.c. samples of acid, without agitation, using strap iron strips as test pieces. Increasing the volume of acid proportionately to the size of the test piece and also agitating the acid during the test still further reduced corrosiveness. (*Supra*, p. 67.) These results were corroborated by tests made by Dr. Prutton. (*Supra*, pp. 68, 69.)

This increase in copper and lead in cross-petitioner's treating acid over that in its storage acid, and the resulting reduction in corrosiveness, is due to the action on the acid of cross-petitioner's specially equipped truck tanks. (Fact Findings 86-90, R. 1491.)

The corrosiveness of cross-petitioner's acid was reduced an average of 42.5% in the two Stella Wilcox treatments, 42% in the Zahn treatment, and 70% in the Crawford well treatment. (R. 1705.) The acid used in these wells was, therefore, only 58% to 30% as corrosive as uninhibited 15% acid, which is only 20% as corrosive as the acid used

by Frasch.[42] Cross-petitioner has thus reduced the corrosiveness of its acid to about 6% to 12% of that of Frasch's acid. Cross-petitioner's dilute inhibited acid is thus manifestly not the concentrated corrosive uninhibited acid of the prior art.

The Claims in Suit

The most limited of the claims in suit are Nos. 8 and 9. They are in the same terms except that claim 9 includes near the end the words "under pressure due to the gas generated thereby." The testimony does not touch upon this clause, but it was explained that the reaction between hydrochloric acid and limestone forms a gas, and if this reaction occurs in the oil-producing stratum it is inevitable that the acid will "act upon the rock formation surrounding the well cavity *under pressure due to the gas generated thereby,*" as called for by the claim.

Claim 8 reads as follows:

> "The method for increasing the output of an oil well which comprises
>
> (a) charging into the pump tube a quantity of a 5 to 15 per cent hydrochloric acid solution containing a relatively small amount of a corrosion inhibitor,
>
> (b) expelling the acid from the tube into the bore of the well by applying pressure thereon,
>
> (c) permitting the acid to act upon the rock formation surrounding the well cavity and
>
> (d) withdrawing the spent acid."

Claim 7 is slightly broader than claim 8. It is quoted as illustrative in the opinion of Judge McDermott. The last two clauses are the same as clauses (c) and (d)

---

[42] PX-343 (R. 1802) gives the corrosion rate of 27.5% HCl (Frasch acid R. 1889) on steel as 1.36 lbs. per sq. foot per day and that of 15% acid as 0.27 lbs. per sq. foot per day or about 1/5 that of 27.5% acid.

of claim 8 and in place of clauses (a) and (b) is the following single clause:

> "introducing into the base of such well a 5 to 20% hydrochloric acid solution containing a relatively small amount of a corrosion inhibitor,"

thus the acid need not be introduced through the well tubing in order to infringe claim 7.

Claim 1 is the broadest and covers a method of increasing the output of a well for producing a fluid mineral product

> "which consists in introducing into the well an aqueous hydrochloric acid solution to which has been added a relatively small amount of an agent capable of inhibiting the action of the acid upon metals."

The language of this claim differs from each of the other claims in suit in that it calls for the use of a hydrochloric acid solution to which the inhibitor "has been added," whereas the other claims call for the use of a hydrochloric acid solution which *contains* an inhibitor.

The District Court considered the formation of the inhibiting agents—copper and lead—by chemical reaction between the acid and lead plates in cross-petitioner's truck tanks to be the equivalent of *adding* the inhibitor to the acid, and held this claim infringed along with the others, the essential feature being the presence of the inhibitor in the acid when it is placed in the well.

RELIEF

We respectfully submit that the decree should be reversed insofar as it relates to the validity of the Grebe and Sanford patent No. 1,877,504, and that the District Court be directed to enter a decree finding said patent valid and infringed and granting the usual relief.

Respectfully submitted,

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JAN 25 1945

CHARLES ELMORE CROPLEY

IN THE

Supreme Court of the United States

OCTOBER TERM, 1944.

No. 50

THE DOW CHEMICAL COMPANY, A CORPORATION,
Petitioner,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY,
A CORPORATION,
Respondent.

No. 61

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A CORPORATION,
Cross-Petitioner,

vs.

THE DOW CHEMICAL COMPANY, A CORPORATION,
Cross-Respondent.

REPLY BRIEF ON BEHALF OF THE DOW CHEMICAL COMPANY.

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REPLY BRIEF ON BEHALF OF THE DOW CHEMICAL COMPANY.

Respondent's brief on invention can be best answered by contrasting our sharply divergent views of the law. Once our difference is understood, the Court will see that much of respondent's brief is superfluous argument of conceded points. Part of it is an erroneous effort to narrow a rule always accepted by this Court, and part of it is a serious distortion of facts relevant on our view of the law.

The Test of Invention.

First, there is only one standard of invention—does the patented thing or process exceed the skill of "an ordinary mechanic acquainted with the business." That rule was established in *Hotchkiss* v. *Greenwood*, 11 Howard, 52 U. S. 248, in 1851 and has never been departed from.

Second, in testing a challenged invention by this rule we have two procedures. (1) In cases where, in the face of a recognized need, no satisfactory solution was reached for many years and the challenged invention answers the need, then it is objectively proved that the solution was beyond the skill of the whole industry, and invention is conclusively established. It is on this test that we rely. (2) In most cases, having no objective historical test, we must resort to the test of restrospective simplicity and attempt to measure, by the personal views of the courts, the presumed ability of the "mechanic acquainted with the business".

In cases of the latter class widespread adoption of the alleged invention is considered only for the purpose of tipping the scales in cases where the court is in doubt as to whether a given change is inventive or only mechanical skill. If it is clear that a change is not inventive, popularity cannot make it so.

But in the former class, when history proves invention, immediate and widespread acceptance has an entirely different probative effect. It is one way (but not the only way) of proving the continued existence of the need and that the challenged invention answered it.

This nice distinction is clearly made in the opinion by Mr. Chief Justice Stone, speaking for this Court in *Paramount* v. *Tri-Ergon*, 294 U. S. 464, 474-6. This established distinction in the probative value of evidence of widespread adoption disposes of much of respondent's discussion.

Third, when the test of history is applicable, things are proved to be inventive which would generally be held mechanical skill without the evidence provided by the lapse of time. This Court has held this explicitly in the cases pointed out in our main brief, notably the *Barbed Wire Case*, 143 U. S. 275; *Carnegie* v. *Cambria*, 185 U. S. 403; *Smith* v. *Snow*, 294 U. S. 1; *Goodyear* v. *Ray-O-Vac*, 321 U. S. 275; and *Paramount* v. *Tri-Ergon*, 294 U. S. 464; and the rule has recently been recognized in the concurring opinion of Mr. Chief Justice Stone and Mr. Justice Frankfurter in *Cuno Engineering Co.* v. *Automatic Devices Co.*, 314 U. S. 84, and in the unanimous opinion of the Court in *Universal Oil Products* v. *Globe Oil Refining Co.*, 322 U. S. 471.

Now we concede, and always have conceded, that the invention here is such that, judged by the test of retrospective simplicity, anybody would think it should have been made as a natural development of the Frasch process. Much of respondent's brief is devoted to detailed elaboration of evidence leading to this obvious and admitted conclusion.

Respondent's contention that the test of retrospective simplicity must always be used, even in the face of the historical proof of invention, leads to an erroneous conclusion. This simply isn't the law. If it were, we would have no case.

Fourth, respondent erroneously asserts that the "long felt want" test is applicable only in doubtful cases, meaning cases where there would be doubt if the test of retrospective simplicity were used. On the contrary, in the comparatively few cases where the long felt want rule does apply, this Court has held inventive things which appear clearly non-inventive when measured by the test of retrospective simplicity and has clearly expressed, at least in the Paramount case and the Universal Oil case, its intention

so to do. In part, respondent's error arises from its failure to comprehend the distinction between the two means of measuring invention and in part from its failure to observe the distinction as to the probative effect of evidence so clearly and nicely made in the Paramount case.

That an apparent close analogy between the prior art and the challenged inventions is wholly immaterial in the "long-felt want" cases, is shown by the following from *Carnegie* v. *Cambria*, 185 U. S. 403, 446:

> "We cannot better conclude this opinion than by the following extract from the opinion of Mr. Justice Bradley in *Loom Co.* v. *Higgins*, 105 U. S. 580, 591: 'But it is plain from the evidence, and from the very fact that it was not sooner adopted and used, that it did not, for years, occur in this light to even the most skillful persons. It may have been under their very eyes, they may almost be said to have stumbled over it; but they certainly failed to see it, to estimate its value, and to bring it into notice. * * * Now that it has succeeded, it may seem very plain to any one that he could have done it as well. This is often the case with inventions of the greatest merit.' "

In *Loom Co.* v. *Higgins* the invention resulted in an increase in over-all yield of from forty yards of cloth a day to fifty yards, a gain of only twenty-five per cent (105 U. S. 590). This gain justified a finding of invention over art so close as to lead this Court to say the workers in the field "stumbled over it". Here the over-all gain of oil was enormously greater, enough to produce brilliant success where the superficially similar art failed.

The above law points dispose of most of respondent's brief, but some of its discussion is relevant.

Long Felt Want Rule Is Applicable.

Respondent argues that testing a challenged invention by the objective test of history is proper only when it is proved that the failures of the art, which in retrospect seem closest to the challenged invention, were *actually* widely known. This position is contradicted by the facts in the controlling cases, by the language of the decisions, and by the principle underlying them.

So far as concerns the statements by this Court, the language in *Paramount* v. *Tri-Ergon*, 294 U. S. 464, 474, is sufficiently illustrative:

> "Where the method or device satisfies an old and recognized want, invention is to be inferred, rather than the exercise of mechanical skill."

All this requires is that the *want* shall have been old and known.

See:

Goodyear v. *Ray-o-Vac*, 321 U. S. 275.
The Barbed Wire Patent, 143 U. S. 275.
Smith v. *Snow*, 294 U. S. 1.

The case cited by respondent on its erroneous proposition (*Toledo Pressed Steel Co.* v. *Standard Parts*, 307 U. S. 350, 356) was held not to be a long felt want case. One of the two patent references issued only three years before the patent in suit. The patentee in an effort to show invention offered evidence of the failure of two experimenters to find a solution. This subjective approach was held to be of no importance.

Respondent assumes from the language of the Court that if the witnesses had known of the prior art their testimony might have had some value. This is obviously not the meaning of the decision.

But even if it were the meaning, the facts in the present case show that the oil industry was fully aware of the closest prior art. The producing division of Ohio Oil Company knew all about the Frasch tests. Frasch, Van Dyke, Irish, and Newbauer were all outstanding in the oil industry from 1895 on and all knew of the Frasch work. Several of them were members of the old Standard Oil group. The Frasch tests were given wide publicity throughout the oil industry by the articles in the Oil City Derrick, and in 1912 the Frasch process was again given publicity by the publication in the Journal of Industrial & Engineering Chemistry (Physical Exhibit 365) of an address awarding the Perkin Medal to Frasch as one of the outstanding chemists of that period. Respondent's president, Earle Halliburton, also knew of acidizing and of inhibited acids. (R. 252-254.)

Turning to the facts in the decided cases, at the time of the Barbed Wire invention there was an enormous need for an economical fence which could be erected in the vast unforested areas of the West where common fence materials were not available. Of the great number who felt the need, probably very few realized that cattle would push down a fence of plain wire, but would avoid even a flimsy fence armed with spurs. There was no showing that many knew of the prior efforts to make barbed wire, and that these failed because the barbs were not locked against turning and sliding. The Glidden wire was held inventive because it supplied the need, although it was so simple that this Court said it was strange that the earlier workers had not made it.

Also in the Incubator case (294 U. S. 1) the *need* was apparent but probably very few knew of the prior futile efforts at staged incubation, or that they failed because of uneven temperatures. Failures generally are not pub-

lished, nor do patents on practically useless, uncommercial things receive wide study. That the matter they contained was available is enough.

A Long Existing Need for Grebe and Sanford Process.

At page 24 of respondent's brief it seeks to account for the failure of the oil industry to adopt the Frasch method by stating that there was little use for such a method at that time. On the contrary, the number of limestone oil fields in production at Frasch's time was large and the extensive growth thereof prior to the Grebe and Sanford invention was great as shown by the testimony of Fitzgerald (R. 178-180), and graphically presented by the table printed in an appendix to this brief.

Another misstatement on the same page of respondent's brief is that "It is a notorious fact that modern wells are greater producers of oil than in 1896." This statement is wholly unsupported by the record and is not true.

Aggregation.[1]

Respondent revives the charge that the Grebe and Sanford process is an aggregation, a charge which was definitely abandoned in the District Court. (R. 1459.)

The trial judge stated that he had considered the question of aggregation and had reached the conclusion that it is not involved in a chemical process, to which respondent's counsel replied (R. 1459):

"Mr. Lyon: • • • I haven't requested any findings

1. Unfortunately, the word "aggregation" is used in two senses in the reported cases. (See opinion of Judge Baker in *Krell Auto Grand Piano Co. v. Story & Clark Co.*, 207 Fed. 946, 951.) In one sense it means that there is no correlation whatever between the elements of the claims, as in *Reckendorfer v. Faber*, 92 U. S. 347. (See also the opinion of Judge McDermott in *Skinner Bros. Belting Co. v. Oil Well Improvements Co.*, 54 F. (2d) 896, 898, which states that a track team is an aggregation and a football team is a combination.) In such cases the claim is void in the absence of *any* prior art. These cases are very rare.

In the other sense, the term is loosely used to mean a non-inventive combination. When the elements do cooperate, but in an old or obvious

on the aggregation feature, because I think that is too debatable. * * * I have treated my findings, as your Honor will see, on the question of invention, testing it in the orthodox fashion and not asking the court to rule that this is an unpatentable thing because it is a technical aggregation.

"The Court: Then I don't need to spend any time on that."

No Need to Explain Theories or Functions in a Patent.

Respondent repeatedly calls attention to the fact that although Grebe and Sanford describe and claim the use of dilute acid, they do not verbally ascribe to it any special function except the ease with which it can be inhibited.

The statute, R. S. Sec. 4888, does not require any description whatever of functions or of the patentee's reason for doing any particular thing. It only requires in the case of a process that he shall file "a written description of the same and of the manner and process of * * * using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it appertains, or with which it is most nearly connected, to * * * use the same; * * *."

While inventors often do expatiate on the merits and theories of their processes, there is no statute requiring them to do so, and they often do not.

An inventor may in his patent include merely a baldly empirical description of his process with adequate operat-

way, and the courts after applying the test of retrospective simplicity find that invention is lacking, sometimes inaccurately call such a combination an aggregation. What is really meant is an exhausted or unpatentable combination. An invention which fills a long felt want should never be so tested.

In this sense the Grebe & Sanford process is not an aggregation. The dilution of the acid and the inhibitor cooperate to get the acid through the pump tube without hurting the tube and without spending the strength of the acid by harmful action on the tube. The use of the conventional pump tube thus made practicable simplifies the whole operation. The pressure applied to the tube forces the unweakened acid out into the rock. Clearly, the features cooperate.

ing directions, and may then claim whatever inventive novelty the process may contain. In subsequent litigation he may prove and rely on any functions or theories of operation which inhere in the described operation.

So too, if he states one theory in his patent he may rely on others not stated, and even if he states an erroneous theory he may prove and rest on another and correct theory. The only statutory requirement is for a clear description of the process, which always consists of an act or operation, or a number of acts or operations. The public is entitled to this clear description of what to do, and that is indispensable. All discussion of theories is superfluous, its insertion is surplusage, and when erroneous it is simply to be ignored like surplusage in any legal document.

In this Court the following statements establish the rule upon an unassailable basis. In *Eames* v. *Andrews* (the Driven Well case), 122 U. S. 40, 55-6, this Court said:

> " 'An inventor may be ignorant of the scientific principle, or he may think he knows it and yet be uncertain, or he may be confident as to what it is, and others may think differently. All this is immaterial, if by the specification the thing to be done is so set forth that it can be reproduced.' "

Also in *Diamond Rubber Co.* v. *Consolidated Tire Co.*, the Grant Tire case (220 U. S. 428, 435-6) this Court said:

> "* * * A patentee may be baldly empirical, seeing nothing beyond his experiments and the result; yet if he has added a new and valuable article to the world's utilities he is entitled to the rank and protection of an inventor. And how can it take from his merit that he may not know all of the forces which he has brought into operation? It is certainly not necessary that he understand or be able to state the scientific principles underlying his invention, and it is immaterial whether he can stand a successful examination as to the speculative ideas involved."

These principles have been applied in countless cases in the various Courts of Appeals. They have been universally accepted.

Sufficiency of Disclosure.

Respondent somewhat tentatively suggests that the Grebe and Sanford disclosure is inadequate. In the light of the statute and of the cases last cited the only thing they are required to disclose is what to do in practicing the process. Not only do they give a good deal of general description, more than the statute requires, but they give in complete detail the steps of a typical operation. Nobody who reads their patent can be in any doubt about how to proceed in practicing their process, and that is all that is required.

Definition of the Claims.

Respondent criticizes as indefinite the requirement of the claims that the acid shall contain a relatively small proportion of an inhibitor, and cites in support of its position the decision in *General Electric Co.* v. *Wabash Appliance Co.*, 304 U. S. 364, 371, dealing especially with functional claims. P. 109 respondent's brief.

Respondent omits the part of the opinion which clearly supports the claims here. Immediately after the matter respondent cites this Court said:

> "A limited use of terms of effect or result, which accurately define the essential qualities of a product to one skilled in the art, may in some instances be permissible and even desirable, but a characteristic essential to novelty may not be distinguished from the old art solely by its tendency to remedy the problems in the art met by the patent."

And in elucidation of this language the opinion cites in the footnote *Davis* v. *New Departure*, 217 F. 775, 782.

The theory of the latter case, which this Court evidently

intended to adopt and express, is that general broad terms (including functional terms) may properly be used to describe old, well known elements, but when there is a special element, whose novelty is relied on to establish patentability, that element must be claimed in precise language. An excellent but general example of nice draughtsmanship is found in the claim sustained in the *Paper Bag Patent case*, 210 U. S. 405, 417, where the old parts were functionally described.

Now in the instant case there was nothing new in the inhibitor *per se*. Many inhibitors were known long before Grebe and Sanford used them in their process, and they claim to have discovered nothing new about inhibitors or the amount of each one needed. Inhibitors differ greatly among themselves in the proportion required, but as to each, the art well knew how much to use.[2] Indeed some inhibitors like "Rodine" were regularly marketed, and their makers naturally gave operating directions. In all cases the inhibitors were used in quite small quantities compared to the acid to which they were added.[3]

So in referring to the use in their process of one of the common inhibitors Grebe and Sanford very properly used general language adequately descriptive of the already well known art.

Just as in *Davis* v. *New Departure* the term "brake mechanism" meant any of the brakes adaptable to the construction, so here "a relatively small amount of a corrosion inhibitor" means any of the inhibitors in the always small proportion proper for that particular inhibitor. This use

2. The inhibitive effects of different small amounts of several inhibitors named in the Grebe-Sanford patent are shown in PX-171. (R. 1723.)

3. The Millon article, published in 1845, states (R. 1583): "In some cases the addition of a *small quantity* of copper sulfate has suspended very appreciably the action of hydrochloric acid." The Watts article, published in 1912 (R. 1587), refers to the "remarkable reduction in the corrosion of iron by sulphuric acid, brought about by the addition of a *small amount* of arsenious oxide to the acid." (Emphasis ours.)

of general terms to describe things already known is not only proper, but this Court has specifically approved it.

Frasch Failed to Solve the Want.

The want which confronted the oil industry before Frasch's date and continued up to 1932, was to recover additional oil from limestone wells at a cost substantially less than the value of the extra oil recovered.

Merely getting oil from the ground, without regard to cost, could be accomplished by means known in Frasch's time, as for example by mining, a process used in Europe. In this country such a method is too expensive.

The Court of Appeals for the Sixth Circuit concluded that Frasch was successful merely because some of the wells he treated showed slightly improved yields. That alone is not enough. The additional oil recovered must more than pay for the additional cost and risk involved. In that respect the Frasch process was a failure. Apparently it failed because the additional yield was too small, he had to pull the pump rod and tube and replace it with a special pipe that was only good for about five treatments (R. 1890), and he used expensive concentrated acid which did not work far enough into the formation. The owners of the well complained about the cost of the treatment to the very well which is claimed to have been most benefited. (R. 1897-1899.)

The Frasch Tests.

The Oil City Derrick reports that the Crossley well increased 300%. Respondent (p. 22) says the production, before acidizing was 1.6 barrels which, if true, would mean an increase of only 4.8 barrels per day. On R. 1898 the complete production records of this well are given. It was treated in August 1895, after August 2 (R. 1894, 1907).

The production in July, the month just before acidizing, was 180.01 barrels, or 6 barrels per day. The best month after treatment was October, with 259.49 barrels, or 8.4 barrels per day. There was a gain of but 2.4 barrels, or a 40% increase, and not a 300% increase as stated by the Court of Appeals for the Sixth Circuit.

The Taylor well was flowing 5 barrels per day before treating. After treating (R. 1657) it did not flow at all. It had to be pumped at great expense (R. 1897-99). We do not know what it would have produced if pumped before acidizing but obviously more than the 5 barrels it produced by flowing. The Oil City Derrick (R. 1659) on February 20, 1896 reported that this well had shown an increased production of $3,500, at a cost of $300. On February 13, 1896 (R. 1897) the Ohio Oil Company, owner of the well, reported that the production had increased by $1,200, at a cost of $1,500. These figures were sent to Van Dyke (R. 1898-9).

A comparison of specific as against general accounts of these two wells indicates that all of the reported production figures were colored or puffed, but whatever may be the fact, the production was insufficient to justify further use of the process even though both Frasch and Van Dyke were then and subsequently in a position to put it into wide use.

We accept respondent's list of tests which, for clarity, we re-arrange in their proper sequential order, adding the name of the proprietor of the wells and showing the initial gain in barrels.

Ex.	R.	Date of Article	Date of Test	Owner	Farm & Well	Production Before Test	Production After Test	Initial Gain
93	1653 / 1894	10/10/95	About 8/5/95	Ohio Oil Co.	Crossley	6 bbl.[1]	8.4 bbl.[2]	2.4 bbl.
144	1657	11/ 9/95		Ohio Oil Co.	Taylor	5[3]	0[3]	loss 5[3]
145	1658	1/15/96		Ohio Oil Co.	Richard Ohio #1	4[4]	11[4]	7[4]
145	1658	1/15/96		Ohio Oil Co.	Cusac-Ohio #2	4	4	0
145	1658	1/15/96		Scott	Arnett	11	16	5
145	1658	1/15/96		Scott	Metz	2.5	11	8.5
146	1660	2/20/96		Neely	Neely	7	17	10
146	1660	2/20/96		Scott	Presser	7.5	20	12.5
148	1662	3/26/96	3/ 4/96	Jones & Ball	O'Connel	6.5	20	13.5
148	1662	3/26/96	3/10/96	Jones & Ball	Bingham	2	45	43
148	1662	3/26/96	1/27/96	Sawyer	Tinsley	1.66	14	12.33
148	1662	3/26/96	Jan. '96	Scott	Hydecker	3	6	3

TOTAL GAIN (omitting Taylor loss) 117.23
AVERAGE FOR 11 TESTS..... 10.68

[1] (R. 1898.) This figure is the average daily production of the well for the month of July 1895. The well was acidized August 5-10 (R. 1894). Respondent gives the pre-acidizing production as 1 barrel based upon an unsigned paper of unknown origin (R. 1894). The 6 barrel figure is based upon the accurate production records of the company.

[2] (R. 1898.) This is the average daily production of the best month following acidizing. The daily average for the 5 months following the month of acidizing, was only 6½ barrels—an increase of ½ barrel.

[3] This well flowed 5 bbls. before acidizing and none after acidizing. A pump was then installed which removed the pressure from a 1200 foot column of oil, estimated at 450 pounds. The total gain for 3 months after treatment was 1500 barrels. (R. 1897.) Thus the average daily gain by *pumping* was only 17 barrels instead of 30.

[4] This test is mentioned twice. These are the first figures given. The second mention (Ex. 146, R. 1660) gives 3 bbls. before test and 12 after.

The gains were so low as naturally to lead to abandoning the process. Note again the results for Ohio Oil Company—first test 2.4 bbls. gain; second test apparently harmful, since the well *flowed* 5 bbls. before treatment and would not flow at all after treatment; third test 7 barrels gain; fourth test no gain. Naturally that company had no more tests made. Scott also had four tests made which showed gains of 5, 8.5, 12.5 and 3 bbls.—total 29 bbls.—average 7.25 bbls. Scott surely would want no more treatments.

Frasch got only one substantial increase (the Bingham) and that was in a well which, as pointed out in our main brief, dropped rapidly in production in its first few days of operation, showing it was probably clogged very near the hole and would have responded freely to any well cleaning treatment. (See page 53 of respondent's brief.)

After March 4, 1896 (save for one test in a dry hole in 1897, R. 1663) the process was permanently abandoned and has never been tried since by anybody. This is a record of more abject failure than was assumed from the mere Frasch patent by the Court of Appeals for the Tenth Circuit.

Respondent argues that one operation of Sprenger (R. 1257) was a test of the Frasch process. This is quite erroneous. After a large number of oil wells in the Greendale field near Midland, Michigan, had been treated by the Grebe-Sanford process, Sprenger treated a well in the same field by putting 60 gallons (6 carboys) of concentrated raw acid in the well with a dump bailer, a device which prevents the acid from contacting the tubing. He then washed down the well with water, necessarily diluting the acid as it was in the open hole and not in the well tubing, and pumped eight barrels of oil on top of the acid, holding it there for 24 hours. This operation was far from Frasch's

process and in no way contradicts our statement that the Frasch process has never yet been used since it was abandoned by Frasch and Van Dyke. All later treatments by Sprenger were with 15% dilute raw acid introduced through the tubing, and these treatements resulted in so much damage to the well equipment that Sprenger quit his job with Oil Makers Company and it changed to the use of *inhibited* 15% acid.

Gains From Respondent's Michigan Infringements.

Respondent seeks to minimize the gap between Frasch's futile tests and petitioner's huge success by asserting that the gains in its accused operations, proven as the specific acts of infringement relied on, were so low as to be comparable with Frasch's. The facts are incorrectly stated.

Petitioner relies for acts of infringement upon respondent's treatments of the Weber Oil Company's Wilcox, Zahn and Crawford wells.

Careful computation from production figures given in the record (R. 302-304) for these wells shows that the wells were initially improved as set forth in the following table. The figures given were arrived at by taking the average production for several days before treatment and comparing it with the average daily production after acidizing, excluding the first day after treatment, as it would include the recovery of oil put in the well before the treatment. (In connection with the Crawford well, the production figures were gauged in a 500 barrel tank. This tank gauged 32 barrels per foot, as shown in the original deposition.)

	Before	After	Gain
Wilcox	10	40	30
Zahn	3.4	25.9	22.5
Crawford	6.7	70.3	63.6
Average Gain			38.7 barrels

This is more than three times the Frasch gains, even as reported by the promotor, Van Dyke.

The Mechanism of the Processes.

The fundamental facts are clear. Frasch used large quantities of raw concentrated acid which he introduced quite slowly through a special coated tube, the use of which required pulling and taking apart the pump rod and pump tube, assembling and inserting the special acid tube, pulling and taking apart the latter, and again assembling and running the pump rod and pump tube, a very cumbersome operation.[4]

Petitioner's process differing in the use of dilute acid, adding an inhibitor and using the pump tube already there, is not only vastly simpler in its mechanics, but produces greatly enhanced yields of oil.

We can speculate endlessly about what takes place thousands of feet underground under conditions which cannot be duplicated for laboratory observation, but the inescapable fact is that there are vast differences between the two processes and petitioner's process succeeds while Frasch's failed.

We think the dilute acid is much better. It has at least received the tribute of universal adoption. Respondent theorizes that Frasch's concentrated acid is really better. Respondent's action in using dilute acid in its infringing operations belies this argument.

Respondent argues that Frasch really used dilute acid

4. The pulling of the tubing before some of respondent's treatments, alluded to by respondent (Resp. Br. p. 57), had no apparent relation to the treatments but was evidently to adjust either the packers, already in place, or the pumps to get the wells in good order in anticipation of enhanced yield. It involved only one removal and return of the usual tubing, through which respondent then introduced its acid.

(page 19 of brief). This is quite untrue. Frasch's actual operation is described in detail in the first Oil City Derrick article (R. 1651). In a typical treatment, he used 65 barrels of concentrated raw acid which entered the rock very slowly. His one-inch tube was such that it held only one barrel of acid in a column nearly 1,300 feet long. After about 60 barrels of acid had entered the rock, he would have a small amount of largely spent acid in the bottom of the well hole and about one barrel of concentrated fresh acid in the tube. Then he began to force water into the 1 inch tube, no mixing of acid and water would occur in the tube and no substantial mixing could occur after the water leaves the tube.

The references cited by respondent to show the use of dilute acid by Frasch do not support this allegation. The only "eye" witness was Nichols, a fifteen year old boy at the time. Nichols is never shown to have seen a well treated with hydrochloric acid of any kind. He stated (R. 1034) that he thought the acid was sulfuric and that it was in carboys. Carboys would mean concentrated acid. There is no evidence that the acid was dilute. Irish (R. 1049) and Neubauer (R. 1060) admitted they never saw a well treated with acid. The publications referred to by respondent clearly demonstrate that the acid used was concentrated, and this use is consistent with the teachings of the Frasch patent.

It is obvious that if equal volumes of dilute and concentrated acid are introduced *at the same speed*, the concentrated should work further out from the well hole. But the mechanical difficulties of handling raw concentrated acid are so great that, in the Frasch process, it was introduced very slowly and so could not do what Frasch wanted to do, which was to work far from the hole, for it spends itself very soon.

As to the speed of reaction respondent challenges our statement of fact. In the first place, anybody who has seen acids, especially strong acids like hydrochloric, react with carbonates knows the reaction is violent and rapid. If the carbonates present a large surface that the acid can get at, all at once, the reaction is very quick. When the carbonate is powdered, as in baking powder and effervescent medicinal salts (*e. g.*, Bromo-Seltzer), even a weak acid results in a reaction complete in a minute or two. When the acid is forced through tiny pores so that a vast surface is exposed to its action, the result must be much the same. Acid works slowly on carbonates only when it must eat off the surface a little at a time before it can get at further areas.

Hence, speed of introduction into the formation is desirable for working far from the well, which both Frasch and Grebe and Sanford wanted to do. It is equally clear that Frasch's acid went in very slowly, the treatment of the Crossly well required six days (R. 1894). Certainly in Frasch's time concentrated raw acid could not be pumped at all (see footnote in respondent's brief, (p. 56), so that Frasch had to use only the hydrostatic pressure resulting from the column of acid in his tubing, until nearly all his largely spent acid in the well hole had seeped slowly into the rock before he could follow it up with water under pressure.

Grebe and Sanford, in the specific example given in their patent (R. 1502), charge in 4,500 lbs. (about 500 gallons) of dilute, inhibited acid, all of which, because of its comparatively inocuous character and the capacity of the tube, could be temporarily stored in the ordinary pump tube. They then force in a quantity of crude oil to force unspent acid into the rock and permit it to act on the formation surrounding the well cavity (Cl. 8, Rec. 1503), whereas in

Frasch the acid is largely spent when entering the formation. Grebe and Sanford's dilute acid can be forced in quickly with little expenditure in the well hole "enlarging the pores and channels in the rock, or opening up new channels." (R. 1502.)

Respondent's argument that the acid is in contact with the well tubing for such a short time that an inhibitor is unnecessary is refuted by the evidence (R. 198, 1799), as well as by respondent's continued use of inhibited acid.

Pressure.

Respondent's brief (pp. 58-60) attacks our statement that Grebe and Sanford, rather than Frasch, taught the use of pressure to force a charge of acid into the oil-bearing formation, before substantial neutralization at the face of the well hole. We granted that Frasch said that pressure should be used, but he showed no means to force an entire charge of his raw concentrated acid into the formation, and we know of no means which was practicable then or now for doing so. Grebe and Sanford, by using inhibited acid, and particularly dilute inhibited acid, made it possible to force the entire charge of largely unneutralized acid into the formation with pumps which were available to Frasch but could not be used with his acid.

Dilute Acid.

Respondent accuses us of changing ground here, and to support its position quotes the colloquy between the Trial Judge and Dr. Bartell, an expert called by us to testify on the factual issue of inhibition of respondent's acid (Br. pp. 4, 15, 16). If the whole discussion be read it is apparent that Judge Tuttle was trying to find out whether the presence of the inhibitor altered the chemical action of the acid

on the rock. We don't think it does and have always so stated. It does permit the acid to be introduced through the conventional pump tubing, and prevents the acid from wasting its strength on the iron and so permits it to do more work on the rock.

But throughout our whole case the continuous argument was that Frasch's process failed profitably to increase the yield of an oil well and was abandoned and forgotten for thirty-six years before Grebe and Sanford succeeded. And in the argument (R. 1443-4) petitioner stressed as the keys to success precisely the same things it urges here, the dilution of the acid, its inhibition, and its introduction through the usual pump tube.

Perhaps all speculation about the underground reaction is improper. In any event the results are clear, and respondent gets them by using the Grebe and Sanford method.

The Injunction in the Williams Bros. Case.

On pages 67 and 95 of its brief, respondent states that in the Williams Bros. suit defendant was enjoined from using inhibited hydrochloric acid upon sandstone formations.

The record citation which respondent gives, namely, page 31 of physical exhibit PX-297, does not support this contention and we know of no evidence in the record which does support it. All that the Williams' record shows is that inquiry was made by interrogatory (Exhibit PX-297, page 18), as to a certain well which turned out to be a well in a substantially insoluble formation and was not relied upon as an infringement. Williams Bros. admitted infringement in acidizing wells in limestone formation and no point was made in the record of the treatment of any sandstone well.

Suggestions by The Pure Oil Company.

The Court of Appeals stated in its opinion:

> "All of the elements of the claimed combination were old. It was old to increase production by the use of hydrochloric acid under pressure. The use of this very process was suggested to Grebe & Sanford by the Pure Oil Company, prior to the issuance of the patent in suit, and was not original with them."

On pages 11 and 69 of respondent's brief, the last of the above quoted sentences is printed in heavy type as a heading, the first two quoted sentences being omitted, giving the erroneous impression that the court found the process of Grebe and Sanford to have been suggested by the Pure Oil Company. Obviously, the Court was merely stating the admitted fact (Finding of Fact 72), that the Pure Oil Company suggested to petitioner the acidizing of oil wells with raw concentrated hydrochloric acid, which suggestion added nothing to the disclosure of the Frasch patent.

Respondent totally misrepresents the relation between the Pure Oil Co. and petitioner, the nature of their dispute and its adjustment. Fairness requires that this situation be understood.

Before the date of their invention, Grebe and Sanford had experimented with putting raw acid in a few of the brine wells in and near Midland which provide petitioner with the brine from which it makes bromine and magnesium. Their object was in part to increase production. (R. 1416-17.) Petitioner also had used inhibited hydrochloric acid to clean calcareous scale out of boilers, and from this and other work Grebe and Sanford knew about the use of inhibitors in hydrochloric acid. (R. 1855.) Neither knew about the Frasch patent, the Frasch tests or had given any thought to the generally known need for increasing oil production.

Thomas of Pure Oil Co. also knew nothing about the Frasch patent, the Frasch tests or about inhibitors (R. 1015). Thomas had a vague idea of using hydrocloric acid to increase oil production, but clearly he had no complete concept of a process, indeed nothing anywhere near as clear as the Frasch patent or the articles describing his tests. With this general idea in mind he visited Grebe and Sanford to inquire about the costs of acid and its availability, told them what he was thinking about and directed their thoughts to the old problem of increasing oil production. Nothing he said to them was anything like as good a disclosure as would have been handing them the Frasch patent, of which they were actually ignorant, but, of course, presumed to know.

On these facts the trial court found (R. 1489):

> "The acidizing of oil wells with hydrochloric acid to increase the production of the wells was suggested to the applicants for Letters Patent 1,877,504 by representatives of the Pure Oil Company and was not original with or conceived by such applicants."

This finding is literally true, but nothing at all can be added to it by inference, or evidence. The acidizing of *oil* wells to increase production was suggested broadly by Thomas, but Grebe and Sanford had previously acidized brine wells with dilute hydrochloric acid with the same object.

Of the three novel points specified in claim 8 all were suggested by Grebe and Sanford. They suggested the use of dilute acid, they suggested the addition of the inhibitor, and they suggested that this innocuous acid could be put down the pump tube without injury.[5]

And when the first test was made, using a well of the

5. Thomas was proposing to deposit the acid in the well by means of a dump bailer or to make the test on an old well that they were going to junk anyway. (R. 1016, 1021.)

Pure Oil Co., petitioner made up a charge of dilute inhibited acid and one of its men put it down the pump tube (R. 1795). Sanford was present and assisted in making the treatment (R. 1999). Respondent's statement, on page 71 of its brief, that the records of petitioner do not show that inhibitor was added to the first acid used for Pure, is incorrect. See R. 110, 111, 113, 114, 1591, 1779 and 1793. Thomas was not even present when the first two treatments to Pure's wells were made and could not have known whether or not an inhibitor was used. (R. 1015.)

In making the early tests Carr of Pure Oil devised a method of packing off the well with oil and for this invention he secured a patent. (R. 1988.) Thomas filed no application for patent and he was not requested to do so by Pure Oil Company, although he discussed his ideas with the officers of that company. (R. 1028-30.) Nor did anyone else connected with Pure Oil Company file an application covering an invention similar to that of the patent in suit.

When Pure learned that petitioner had applied for a patent, not knowing just what the application covered or what the art was, it protested, as people often do who have a broad notion and fear that it is being appropriated. There were no interferences declared by the Patent Office. After the Carr and Grebe-Sanford patents issued, a conference straightened the matter out without real controversy and a contract was entered into, dated January 31, 1933. (PX-369, R. 1873.) This was superseded by contract dated June 30, 1934. (PX-370, R. 1877.)

When the parties met, the Frasch patent had become known to both, although the Oil City Derrick articles had not. So it was assumed and agreed by both that Grebe and Sanford had invented those changes over the Frasch patent which they claimed, *i. e.*, the introduction of dilute inhibited acid through the pump tube, and that Carr had

invented the changes which he claimed, *i. e.*, the use of the oil packing system. (R. 1988.)

This brought about a situation very common in dealing with patents. Each had invented something that the other wanted to use. So a trade was made. For its comparatively small use of the process in its own wells Pure got a free license under the Grebe and Sanford patent. Because petitioner hoped to treat wells for the whole trade, and expected to use the Carr packer in this vastly larger number of wells, it agreed to pay Pure five dollars a well for the right to use the Carr packer.

There was absolutely nothing in the settlement in the slightest degree casting any doubt on the originality of Grebe and Sanford's claimed concept. We freely concede that Thomas led Grebe and Sanford to think about the oil problem, but that is all he did. Every feature of their claimed novelty over Frasch was their own idea.

Thomas himself says that dilute inhibited acid was suggested by Grebe and Sanford at their first interview. (R. 1016, 1018, 1030.) The use of dilute acid is shown in the formula worked out by Grebe's assistant and handed to Thomas at the first interview. (R. 1012, 1993.)

The Gypsy Operations.

Most of what is said by respondent about the Gypsy operations is answered in our main brief.

We repeat that Gypsy used concentrated acid, and it had a very good reason for so doing. It had heavy deposits of scale inside its pump tubes, and it wanted to dissolve as much as it could with the volume of acid that would fill the tube. At times it used acid outside the tube also. Even concentrated acid dissolves only about one-fifth of its volume of calcium carbonate, and to get a large amount of scale into solution the acid should be as strong as possible.

One witness (R. 1066) referred to the acid in one test as dilute, but this must have been an error because all the calculations as to the amount of acid needed and to be used were based on 20° Baume (31.45%) acid. (R. 1677.) Besides, the acid was in carboys, and this usually means fresh, concentrated acid as shipped by the makers. The witness undoubtedly meant each 10-gallon carboy of concentrated acid was "diluted" with one quart of inhibitor solution. The witness Kiser refers to the acid as being "diluted" with Rodine (R. 1076), and this meaning of the word "dilute" is the only one consistent with the testimony about carboys and the calculations as to how much limestone the acid would eat. (R. 1074, 1677, 1922.)

However, one outstanding point about these tests is that they were abandoned and in total disuse for about two years before the Grebe and Sanford invention, and respondent's explanations are futile in the face of the admitted fact that during that time Gypsy was trying other expedients for removing scale and made no attempt to treat the producing formation of any of its limestone wells.

The other vital point is that these tests do not anticipate the Grebe and Sanford invention. They were performed for a different purpose and taught nobody to practice the patented process during the nearly five years which elapsed between Gypsy's first attempt to remove scale from sandstone wells and the time it employed petitioner's licensee to acidize the first of its limestone wells ever to be treated.

The Operations of the Oil Makers Co.

Little need be added to what is in our main brief. This evidence was produced by us to show the extensive injury to equipment caused by the use of *dilute raw* acid. It clearly does prove that there was damage sufficient to

make the whole value of the operations very dubious and to force the Oil Makers Company to adopt directly infringing operations with inhibited acid.

Sprenger testified that there was known, substantial damage by the raw hydrocloric acid to at least seven of the twenty-five wells that he treated while employed by Oil Makers (R. 1259-71):

> "I talked with my associates and told them that I was quitting. I told them that I believed that the business was too big for us. We were causing more damage than we were making money to pay for. I told them that unless we found some way to use the acid without causing so much trouble to the steel material in the well, that it was useless to continue • • •" (R. 1271).

Respondent's discussion does not fairly separate the early operation with dilute raw acid from the later one using dilute inhibited acid.

Operations of Chemical Process Co.

The statement in our main brief that the use of raw acid by this company is supported by the evidence of only one biased witness is challenged in a most surprising fashion. In a foot-note (Res. Br. p. 84) respondent quotes Dr. Knappen to the effect that he understood this company (Chemical Process) did not use an inhibitor after the filing of the Williams Bros. suit. This evidence is not only formally incompetent, but Knappen's immediately following statement shows it is valueless.

He said (R. 1092): "The other company I have reference to is the Halliburton Oil Well Cementing Company (respondent) who have treated wells for us and, so far as I am advised, have not used inhibited acid."

His evidence is no better as to the acid of one company than the other. Both lower courts, after a careful review

of the facts, found that respondent's acid *is* inhibited. And since lead sheets were found in the tanks of the Chemical Process Company it doubtless inhibits its acid in the same surreptitious way.

Infringement.

On this branch of the case the facts found below should not be disturbed since there is no conflict between Circuits. It should be assumed that the lower courts' finding that respondent's present process infringes is correct. (Finding 84, R. 1490.)[6]

Respondent argues (pp. 104, 105) that Grebe and Sanford are limited to an inhibitor which will not attack metal surfaces. Respondent implies that copper and lead chlorides, as used by it, do attack metal surfaces. Arsenic is Grebe and Sanford's preferred inhibitor.

The mechanism of the inhibited action of arsenic is identical with that of lead and copper. The arsenic is introduced as arsenic oxide and promptly forms arsenic chloride (R. 1941). The lead, copper and arsenic chlorides all inhibit the action of hydrochloric acid on iron by plating out on the iron surface to replace dissolved iron removed by the acid. Protection is thus secured by replacement of a thin layer of iron, perhaps only one atom thick, by a corresponding layer of metallic arsenic or lead or copper, as the case may be.

6. It was admitted at the trial that respondent used inhibited 15% hydrochloric acid in infringing acidizing treatments during 1935 and until the Grebe and Sanford patent in suit was sustained in the *Williams Bros.* case in January, 1936. (R. 254, 256, 257, 259 and 260.) In view of this admission, the question of infringement by respondent's present process becomes of secondary importance, being in fact merely one of venue.

Respondent (a Delaware corporation) is licensed to do business in Michigan. This court held in *Neirbo* v. *Bethlehem Shipbuilding Co.*, 308 U. S. 165, that such a license waived the residence requirements for venue under Judicial Code 51. If this Court intended this same waiver to apply to the residence requirements of Sec. 48 governing venue of patent suits, then venue is not an issue, and infringement by respondent's present process need not be investigated.

As to the mechanism there is no doubt. Rebbeck says (R. 1346):

> "• • • in order to work arsenic has to plate out and in order to plate out iron has to dissolve, and if iron dissolves, it is dissolving, it is not remaining inert or unattacked."

To the same effect is the article by Oliver P. Watts (R. 1587):

> "Iron dissolves and by so doing deposits arsenic upon the surface of the iron. Since the arsenic is deposited simultaneously with the dissolving of the iron, and only as a result of this dissolving, • • •."

Many other metallic salts (including copper and lead chlorides) plate out in the same way, taking the place of the iron which dissolves, and this is precisely what occurs in respondent's process held to infringe.

Respondent further urges that the patent in suit should be limited to non-metallic inhibitors because of an alleged "disclaimer" of all metallic chlorides, whereas the inescapable fact is that the preferred inhibitor of the patent is a small amount of a compound of the metal, arsenic, which when added to hydrochloric acid is at once acted on by the acid to form chloride of arsenic. This use of the term "disclaimer" by respondent is grossly misleading. Actually no disclaimer of any kind was filed, and rightly considered the argument is merely that of file wrapper estoppel, based on a statement made by the patent solicitor during prosecution of the application.

To understand what the solicitor meant, we must discuss a little elementary chemistry.

In most chemically active aqueous solutions the dissolved material is largely ionized, *i. e.*, it splits into two parts, one of which carries a positive and the other a negative electric charge.

When common salt (NaCl) is dissolved in water the salt is largely ionized into positively charged sodium (Na) ions and negatively charged chloride (Cl) ions. Similarly, in a solution of arsenic chloride ($AsCl_3$) the dissolved material is largely ionized into positively charged arsenic (As) ions and negatively charged chloride ions. It is the arsenic ions in the latter solution which act to inhibit the action of hydrochloric acid on metals such as iron. The chloride ions have no inhibiting effect. Similarly they have no inhibiting effect in a solution of sodium chloride. No chloride ion, whether formed by the ionization of a metallic chloride or otherwise, will act as an inhibitor.

It is the negative chloride ions normally appearing in the well in conjunction with the well water thereof, *i. e.*, the alkaline well solutions, that were under discussion in the Patent Office and not the positively charged metallic ions, which were claimed and allowed as the effective inhibitor.

The file wrapper shows that this was clearly the meaning of the statement of the attorney (R. 2036) and was so understood by the Examiner in subsequently allowing the claims.

When arsenic in any of the usual compounds is put into hydrochloric acid we get chloride of arsenic, a metallic chloride (see Beneker patent R. 1941), which ionizes at once so that the solution contains positively charged arsenic ions. These are what do the work. And when copper and lead salts are present in small quantities as they are in respondent's process, they too ionize so that we have positively charged copper and lead ions which do the work.

The acid used by respondent contains small amounts of copper and lead, which both the lower courts found to inhibit the acid as required by the patent in suit.

Respondent's acid was inhibited on the average about

52% (R. 1705). (The Court of Appeals found it to be 40-60% (R. 2054). This is squarely within the range of inhibition of various inhibitors set forth in the Grebe and Sanford patent. The chart in the appendix, p. 35 shows graphically the comparative results secured by various inhibitors named in the patent and respondent's inhibitors. As the chart shows, and as the Court of Appeals found: "There is no substantial difference between the results secured by the respondent and that secured by petitioner, and the method used is essentially the same" (R. 2054).

In view of the above the only question on infringement is one of fact—do the lead and copper in respondent's treating acid act as inhibitors? Both courts below answered that question in the affirmative, and under settled practice here that question is not open.

The Tenth Circuit Opinion.

In arguing the Williams Brothers case we stated as we do here, that invention by Grebe and Sanford depended upon the application of the "long-felt want" rule and could not be supported by the more commonly applied test which this Court has recently and correctly called the uncertain test of "retrospective simplicity". The Tenth Circuit Court of Appeals accepted the "long-felt want" test as the proper measuring rule and therefore correctly rejected all varieties of argument applicable to the rejected rule.

Most of respondent's criticism of the opinion is that the Court refused to consider these inapplicable arguments, such as that, both Frasch and the use of inhibitors being old and well-known, any skilled man should have seen that they could be combined. But for thirty-six years neither the skilled men nor the experts in the industry saw that this combination should be made. Hence all such arguments become irrelevant.

The Court of Appeals for the Tenth Circuit held Frasch was a failure. The present record makes a still better case for patentability of Grebe and Sanford over Frasch for it shows twelve actual Frasch tests which received wide publicity, uncommercially low yields in these tests, and thirty-six years during which the whole industry made no effort to acidize limestone wells, or to use the Frasch process or anything like it.

The Court of Appeals for the Tenth Circuit correctly held the Gypsy work was abandoned and that it would not have anticipated if fully established as prior art. It was dropped completely. The explanation now given, that oil was cheap, etc., is completely answered by the fact that Gypsy was still trying, by other means, to remove scale. Furthermore, Gypsy's work on scale removal didn't teach Gypsy to acidize wells to increase production. That work was done for it by petitioner's licensee under the patent in suit and after thus learning of the efficiency of the Grebe and Sanford process Gypsy proceeded promptly and extensively to use it (R-1088, 1090, 1104). The quotation from Knappen (Respondent's Brief, pp. 68, 69) is incomplete and its use is misleading. Knappen said: "The reason that Gypsy employed Dowell, Incorporated, to treat certain of their wells was that at that time we did not have our acid treating equipment in shape to do the work;" (R. 1089).

Naturally they didn't. The idea of acidizing with considerable volume of dilute acid forced out into the formation was new to Gypsy and it had no tanks or acid handling devices of any kind on hand. In its early, abandoned work on scale removal Gypsy used concentrated acid, received as usual from the maker in ten gallon glass carboys, and poured the acid from these carboys, ten gallons at a time, down the wells.

Treatments by the Grebe-Sanford process require suitable equipment for making up considerable charges of inhibited dilute acid and getting it to the well and down the pump tube. The whole idea was new to Gypsy, and while it could easily have obtained the proper equipment, it did not have it or need it for its scale-removal tests.

The Court of Appeals for the Tenth Circuit rejected the Gypsy tests as an anticipation on clearly correct grounds, and having rejected the test of retrospective simplicity it refused to consider this work as an element of art to be added to the Frasch art. In short, under the precedent established by this Court it refused altogether to consider how close the art seems in retrospect, so long as the great problem remained unsolved.

With its view of the apposite rule of law the Court of Appeals for the Tenth Circuit would have decided the present case as it did the Williams case. In the long-felt want cases nothing short of a complete anticipation which answers the want should defeat a patent.

Respectfully submitted,

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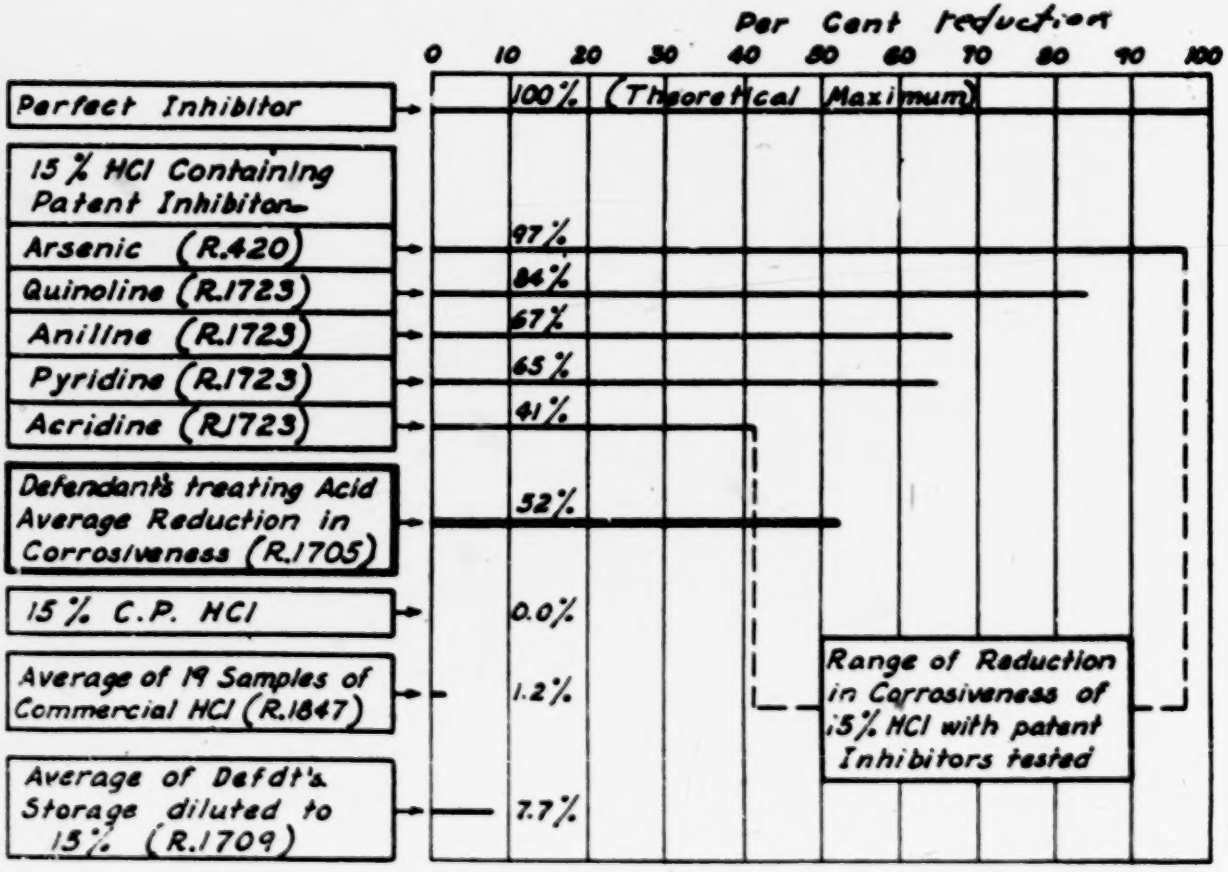
January 24, 1945.

APPENDIX.

INFRINGEMENT.

Reduction in Corrosiveness.

Comparison of the Effect of Respondent's Inhibitors and Those Named in Grebe and Sanford Patent.



IN THE

Supreme Court of the United States

OCTOBER TERM, 1944.

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BRIEF ON BEHALF OF HALLIBURTON OIL WELL CEMENTING COMPANY.

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Cross-Respondent.

BRIEF ON BEHALF OF HALLIBURTON OIL WELL CEMENTING COMPANY.

Statement of the Case.

The Dow Chemical Company filed this suit in the District Court for the Eastern District of Michigan alleging ownership of the Grebe & Sanford patent and infringement thereof by Halliburton Oil Well Cementing Company defendant.* From a decree dismissing the suit [R. 1492] plaintiff appealed to the Court of Appeals for the Sixth Circuit, which court affirmed the appealed decree [R. 2051]. Both the District Court and the Court of Appeals found the Grebe & Sanford patent invalid, but, if valid, infringed.

Prior to the commencement of this suit plaintiff filed a suit in the United States District Court for the Northern District of Oklahoma against Williams Bros. Well-Treating Corporation for infringement of this Grebe & Sanford patent. The District Court adjudged the patent invalid. Upon plaintiff's appeal the Circuit Court of Appeals for the Tenth Circuit reversed such judgment, holding the patent valid and infringed. (*Dow Chemical Company v. Williams Bros. Well-Treating Corporation*, 81 F. 2d, 495.)

The Tenth Circuit Court held that Grebe & Sanford "conceived the idea of dissolving the formation in which nature stored its oil." (*Dow Co. v. Williams Bros. Co.*, 81 F. 2d, *ll.* 12-14, p. 500.) It stated in effect that "this process increased the ultimate recovery from the sand, and that the production of more oil in a more efficient way is accomplished by the patent in suit." [*Cf.* Opinion 6th Cir., R. 2058; 139 F. 2d, 477.]

The opinion of the Sixth Circuit Court contrasts the rationale of the divergent opinions. It points out that

*To avoid confusion the parties will be referred to herein as "Plaintiff" and "Defendant" respectively.

"the increase in the flow of the well is not the problem claimed to be solved by the alleged invention, * * *" [R. 2058]; that the Grebe & Sanford patent recognizes that subjecting the oil-producing formation to hydrochloric acid under pressure to open up the pores and channels of the formation, permitting a freer flow of oil, was public knowledge prior to Grebe & Sanford's alleged invention; that such process is fully disclosed in the Frasch Patent No. 556,669 of 1896 [R. 1935]; that the object of Grebe & Sanford's purported invention "is simply to protect the equipment from the hydrochloric acid" and that "The single question is whether the conception of adding a corrosion inhibitor to hydrochloric acid for use in acidizing wells in order to reduce corrosion requires anything more than ordinary skill of the calling or involves any patentable invention." [R. 2058; 139 F. 2d, 477]; it referred to the testimony of plaintiff's expert Bartell, who in response to inquiry by the District Court as to what Grebe & Sanford claimed over the Frasch Patent disclosure, stated that so far as increasing the flow of the well, Grebe & Sanford did not claim to have accomplished anything; that they claimed no new result except protection of the well equipment; that the addition of the inhibitor has no effect on the reaction of the acid upon the limestone [R. 323-324]. It concluded "It was old to increase production by the use of hydrochloric acid under pressure. * * * It was old to use inhibitors with hydrochloric acid * * * to reduce corrosion * * *" The only novel element here was that appellant first charged the inhibited hydrochloric acid into the limestone formation through the pump tube. The application of these two old principles to an oil well and the obvious step of conducting the acid through the pump tubing did not constitute invention, in view of the

prior art as presented in this case. All that was required was expected mechanical skill. No new result was achieved." [R. 2059; 139 F. 2d, 477.]

Plaintiff in its brief herein practically abandons all claim that patentable novelty or patentable invention is to be found in Grebe & Sanford's addition of a corrosion inhibitor to the acid. Plaintiff now predicates its claim of patentable novelty and invention upon the use of a more dilute hydrochloric acid, asserted by plaintiff to be more efficient in degree in dissolving limestone formation of an oil well. This, plaintiff now urges, is the very essence of the Grebe & Sanford patent disclosure. "The inhibitor prevents the acid from attacking and damaging such metal equipment of the well as the pump tubing, well casing, etc., but does not affect the action of the acid on the limestone." (Dow Br. p. 4.) "Inhibited acid presumably attacks limestone the same as does raw acid and we have always conceded this. Therefore, the difference in results must lie largely or wholly in the relative concentration of the acid and the manner of its introduction." (*id.* p. 41.) The Tenth Circuit Court's Opinion does not turn upon such distinction. On the contrary, no reference whatsoever thereto is to be found in such Opinion. The opinion is predicated upon some mysterious unexplained difference. "The inhibiting reagent alone could not dissolve the limestone; the acid without the inhibitor had proven to be a failure. Only through the co-action of the two was the result accomplished in a practical way." (81 F. 2d 499.) Nor is there any reference whatsoever in the Grebe & Sanford patent or anything even inferentially suggesting that increase in production of oil is dependent upon or is effected by the degree of dilution of the acid. Nor was any such contention made in the

Sixth Circuit Court; no reference thereto is found in the Sixth Circuit Court's Opinion. The record herein contains no testimony on the subject. Nothing in the record sustains this new theory so advanced for the first time in this Court.

To support its claim that the inventive feature of the patent is the use of a more dilute hydrochloric acid, plaintiff's brief herein speculatively advances the following theories:

(1) "Concentrated acid is more viscous than dilute acid and reacts more violently with limestone. Consequently, it enters the small rock pores more slowly and expends itself on the walls of the well hole and the rock closely adjacent thereto." (Br. p. 14.)

(2) That "The resulting spent acid solution is a viscous concentrated calcium chloride brine which must be forced out into the formation ahead of the incoming acid before fresh acid can enter and enlarge the pores. There the spent acid hinders the flow of oil to the well following the treatment." (Br. pp. 14 and 15.)

(3) That "The high concentration of the acid used by Frasch was no doubt responsible for an even more serious defect in that process—viz., the failure to produce increases in production sufficient to justify the expense of the treatments." (Br. p. 33.)

(4) That in the actual treatment in an oil well "concentrated acid forms and takes up calcium chloride with much greater rapidity than does dilute acid and the higher the percentage of calcium chloride in the spent acid the more viscous it becomes." (Br. p. 34.)

(5) That "this spent acid would have to be forced back into the formation ahead of the incoming fresh acid be-

fore the latter could reach and attack the pores in the formation away from the well hole." (Br. p. 34.)

(6) That "Another possible explanation of the unsatisfactory increases that resulted from the Frasch treatments was the difficulty of removing this viscous spent acid from the pores of the rock. It had to be forced out ahead of the oil by the natural rock pressure and to the extent that this spent acid remained in the pores the flow of oil to the well hole was blocked or lessened." (Br. p. 34.)

(7) That "although Frasch's concentrated acid reacted much faster with the rock and so should have been forced in much faster to prevent its spending most of its strength enlarging the well hole and the pores close to the hole, inherently it went in much more slowly under comparable conditions." (Br. p. 37, *cf.* 39.)

This Court is now asked to ignore the fact that the Grebe & Sanford patent was granted for adding a corrosion reducing agent to the acid and to decide the validity of the patent upon speculations and theories asserted in plaintiff's brief. Such mere speculations and assertions of differences in the effect of dilute acid over a more concentrated acid in dissolving limestone formations, cannot supply the failure of proof. No such speculations were advanced as issues of fact by plaintiff upon the trial. Plaintiff offered no testimony in support thereof. No finding of fact by the District Court or by the Court of Appeals in this case bears even remotely upon these new speculations and theories advanced by plaintiff in its brief. Nor were any such factual speculations and theories referred to by the District Court or Court of Appeals in the *Williams Bros.* case.

Summary of Argument.

1. The Grebe & Sanford Patent.

What is the alleged invention as set forth in this patent? It is the use of a corrosion inhibiting agent in the hydrochloric acid to minimize attack of the acid upon the metal equipment of the well. Nothing in the patent indicates an assertion that the acid acts in dissolving limestone well formation in any different manner or degree or produces any different result than in the admittedly old Frasch patent method.

2. Plaintiff's Novel Speculative Theories.

There is nothing in the Grebe & Sanford patent to support the speculations of plaintiff's brief and the arguments founded thereon with respect to any difference in operation of the acid whether a commercial hydrochloric acid (30% HCl, 70% water) or a 5 to 20% acid is used. Plaintiff's speculative theory regarding the viscosity of the acid has no foundation in the record or in fact.

3. Introduction of the Acid Into the Well Through the Ordinary Pump Tube Already in the Well.

There was nothing inventive in this. Inclusion of the use of the pump tube in claims 8 and 9 was necessary to set forth some utility for the inhibiting agent in the acid.

4. Forcing the Acid Into the Rock by Pump Pressure.

This was not novel. It is completely disclosed in the Frasch patent and in the Oil City Derrick publication.

5. The Use of Hydrochloric Acid to Dissolve Limestone Formation in an Oil Well to Facilitate the Oil Flow.

Both the Frasch patent and the Oil City Derrick publication [PX 142, R. 1656], published October 10, 1895, made part of the public knowledge such use of hydrochloric acid.

6. The Frasch Use Was Successful.

The increases in production were fully comparable to the increases in production achieved by defendant in treating the three wells charged to infringe herein.

The Frasch patent 556,669 [R. 1935] disclosed "The method of increasing the flow of oil-wells in limestone formations, by introducing into the well a large quantity of a chemical reagent which is a solvent of the rock (such as hydrochloric or muriatic acid), and subjecting such reagent to strong pressure." [Claim 4 – R. 1937.]

7. The Frasch Patent and the Oil City Derrick Publication.

Under the patent statute R.S. 4886, 35 U.S.C.A., Sec. 31, all disclosed therein became part of the public knowledge. The statute prohibits the later grant of a patent thereon. From the fact that this patent and publication were in fact unknown to American oil producers and petroleum scientists "nothing can be deduced favorable to the (Grebe and Sanford) patent". *Bone v. Commissioners of Marion County*, 251 U. S. 134, 144. *Cf. W. H. Butcher Packing Co. v. Cincinnati B. S. Co.*, 35 F. 2d 567, 569.

8. THE ADDITION OF A CORROSION REDUCING AGENT TO THE ACID PRODUCED NO NEW RESULT: IT DID NOT CHANGE THE EFFECT OR MANNER OF DISSOLVING THE LIMESTONE FORMATION: IT MERELY SUBSTITUTED ONE KNOWN MEANS FOR REDUCING CORROSION OF THE METAL EQUIPMENT OF THE WELL FOR ANOTHER KNOWN MEANS. THIS WAS NOT A NEW PROCESS. NO INVENTION WAS INVOLVED.

It is an admitted fact in this case that the so-called inhibiting agent has only its old purpose and effect, of reducing the corrosiveness of the acid incident to its contact with the metal parts: that it has no effect upon the action of the acid in dissolving the limestone in the well formations. No new function is evolved from this combination; the results achieved are only those old separate results which follow from the separate well-known operations of each of these respective elements.

9. HYDROCHLORIC ACID CONTAINING "1 TO 5 PER CENT OF AN ARSENIC COMPOUND" WAS A PART OF THE PUBLIC KNOWLEDGE PRIOR TO GREBE & SANFORD'S CLAIMED INVENTION. ITS USE TO REDUCE CORROSION IN TRANSPORTING ACID TO ITS PLACE OF USE WAS ALSO PUBLIC KNOWLEDGE.

The Gravell patent 1,678,775, granted July 31, 1928 [R. 1947] added to the fund of public knowledge the addition to hydrochloric acid of an arsenic trioxide (As_2O_3) [R. 1948, *ll.* 1-5] for the purpose of preventing the acid attacking the steel drums or containers in which it is stored or by which it is transported. To use Gravell's inhibited acid for the purpose of conducting it to an oil well and thence down through the casing or pump

tube of the well, thus utilizing the inhibition to protect the metal parts of the well was not inventive. It was a use for which such inhibited acid was available. It was the mere substitution of one method and means of protecting the well equipment from corrosion for another method and means employed by Frasch. The limitation of effect of corrosion inhibition of the acid was as to its effect upon the well equipment and without respect to the reaction of the hydrochloric acid in dissolving limestone. The Sixth Circuit Court of Appeals was correct in stating that "The application of these two old principles to an oil well and the obvious step of conducting the acid through the pump tubing did not constitute invention, * * *. All that was required was expected mechanical skill. No new result was achieved." [R.2059.]

10. The Gypsy Oil Company Use.

The facts in connection with this use particularly illuminate the actual knowledge possessed by scientists in 1928. Gypsy Oil Company's problem was the formation of limestone scale on the casing, tubing, etc. of the well and upon the face of the sand in its well. It used inhibited acid which dissolved and removed this scale. It secured its knowledge of such inhibited acid from the Mellon Institute at Pittsburgh. While a single public use invalidates a patent, *Electric Storage Battery Co. v. Shimadzu*, 307 U.S. 5, 20, the record establishes successful use of inhibited acid upon other wells by the Gypsy Oil Company.

This use by Gypsy Oil Company was not abandoned. The reason Gypsy Oil Company called plaintiff to treat a well in 1933 was because the well was located in Kansas remote from the place where Gypsy was operating. [R. 1089.]

11. The Use of This Very Process Was Suggested to Grebe & Sanford by the Pure Oil Company and Was Not Original With Them.

The Pure Oil Company suggested to plaintiff and its alleged inventors, the use of hydrochloric acid to increase oil well production by dissolving limestone formation. It was the Pure Oil Company that took up such method in 1932. It was supposed by both Pure Oil Company and plaintiff to be a discovery. Neither had any knowledge of the Frasch patent or Oil City Derrick publication.

The Pure Oil Company asserted the rights to a patent upon such process. The dispute between Pure Oil Company and plaintiff was settled by a contract between the parties in which Pure Oil was granted "without royalty charge a non-exclusive license under Patent 1,877,504 and under any other patents which Dow may acquire, own or control relating to acid treatment of oil or gas wells." [R. 1874.]

12. Oil Makers Company.

Dougherty, Markey, Lee and Sprenger in June, 1932, formed a company to go into the business of acidizing wells for others [R. 1195]. In October, 1932, they organized as Oil Makers Company [R. 1256]. They began acidizing wells in June, 1932, and continued in business for about a year. They used raw commercial acid purchased from Penn Salt Co. [R. 1166, 1193, 1196, 1197, 1199]. In September, 1932, they purchased some acid from Grasselli Chemical Company containing "Duclean No. 2" a pickling compound [R. 1174-6; 1178-80; 1193, 1199-1201, 1236] and operations were successful with both raw commercial hydrochloric acid and with the in-

hibited acid. Oil Makers went out of business because they did not have sufficient capital and because their customers were afraid of suit by plaintiff.

13. THE WILLIAMS BROS. DECISION. ITS ERRONEOUS ASSUMPTION OF FACTS, AND A COMPARISON THEREOF WITH THE FACTS ESTABLISHED BY THE RECORD HEREIN.

In its opinion the Sixth Circuit Court of Appeals points out that the evidence contained in the record in the instant case compels a different conclusion from that arrived at in the *Williams Bros.* case opinion (139 F. 2d 475). Under this heading defendant will consider the errors of fact and of inference upon which the conclusion of the Tenth Circuit Court of Appeals is based and point out that each of these inferences and errors of fact is disproven by the record in the instant case.

14. THE DOCTRINE OF LONG FELT WANT IS NOT APPLICABLE TO THIS CASE.

Like immediate public adoption and use as a factor to be considered in a case where invention is in doubt, the long-felt want doctrine applies only in cases of such doubt.

The hiatus in plaintiff's argument is that there is a total lack of evidence that any oil producer or scientist engaged in the oil well production art actually had any knowledge of the Frasch patent, the Oil City Derrick publication, or the patents disclosing the use of an agent which added to hydrochloric acid would control, inhibit or minimize the corrosive action of the acid upon metal parts. In the absence of such proof the doctrine does not apply. *Toledo Pressed Steel Co. v. Standard Parts*, 307 U. S. 350, at 356.

15. Defendant Added No Inhibiting Substance to Its Acid. Its Method Dissolved Iron, Steel, Lead and Copper Forming in the Acid the Disclaimed Metal Chlorides.

16. The Patent Does Not Disclose That a Metallic Chloride May Be Used as an Inhibitor.

17. The Grebe & Sanford Patent Sets Forth the Alleged Invention as Consisting in the Addition to the Hydrochloric Acid of a Substance Which Prevents the Dissolving Action ("Attack") of the Acid Upon Metals, "Iron or Steel, Copper, Etc."). [R. 1501, *ll.* 76-77.]

18. The Adjudication of Infringement Is Founded Upon the "Minute Quantities of Copper, Iron and Lead Chlorides (Which) Are Deposited on the Inside of the Steel Container, Forming a Protective Coating." [CCA6 Opinion, R. 2054.]

19. Plaintiff Disclaimed Metallic Chlorides as the Equivalent of the Corrosion Inhibiting Substances Specified in the Patent.

20. The Infinitesimal Amount of Copper Chloride Does Not Fall Within Any Range of Inhibiting Substance Specified in the Grebe & Sanford Patent.

BRIEF FOR RESPONDENT ON THE QUESTION OF VALIDITY.

The Grebe & Sanford Patent [R. 1501].

What is the alleged invention as set forth in this patent?

It refers [p. 1, *ll.* 43-57] to the method described in the Frasch patent 556,669 [R. 1935] and states: "The acid has the effect of attacking and dissolving the rock, thereby enlarging the cavity at the bottom of the well, or the channels and pores in the rock through which oil flows to the well."

Nowhere in this patent is there any assertion that Frasch's hydrochloric acid was not or is not efficient for this purpose. Nothing is said about any difference in kind or degree of dissolving of the rock or enlarging the channels or pores dependent upon the degree of dilution of the acid. The patent states:—

> "In actual practice, however, this method has never been generally adopted, due to the fact that the acid attacks the metallic casing, pump tube, etc. about as actively as the rock, and causes serious damage thereto." (*ll.* 52-57.)

It then states the alleged discovery:

> "We have now found that the last-mentioned method may be adapted for use in increasing or restoring the flow of oil wells by suitable modification without material injury to the casing or other metallic parts of the well. * * *
>
> "In carrying out our improved method we employ a mineral acid, preferably hydrochloric acid, inasmuch as the latter upon reacting with the calcareous rock forms water-soluble salts which remain in solution and are removed from the well with the spent

> acid. To the acid we add a small amount of a substance capable of inhibiting attack of the acid upon metal surfaces, e. g. of iron or steel, copper, etc., with which it comes in contact." (*ll.* 58-78.)

Substances capable of inhibiting attack of the acid upon metal surfaces are then listed.

According to the import of the patent, the object of the invention is to avoid the injury to the metallic equipment of the well by avoiding corrosion of the metal by the acid. The improvement is the substitution of inhibition of the acid for the mechanical means disclosed in the Frasch patent for avoiding such injury.

The Sixth Circuit Court found that: "the patent itself recognizes the fact that this idea was conceived by Frasch, and that increase in production was obtained by the Frasch method; and in the instant case appellant's expert stated that the inhibitors 'would have no effect on the acid in connection with its reaction upon limestone,' and that the result 'would be limited apparently to the equipment, rather than to the well itself.' Hence under appellant's own testimony the increase in the flow of the well is not the problem claimd to be solved, for since the addition of the corrosion inhibitor to the hydrochloric acid does not affect the action of the acid upon the limestone, no new process is created." [R. 2058].

The District Court questioned plaintiff's expert, Dr. Bartell, respecting the Frasch patent and the Grebe & Sanford patent.–

> "The Court: Well, now, what new do they claim? What improvement do they claim they made over that? How do they claim they change?

"A. My understanding is that the main claim for improvement is the addition to the hydrochloric acid of some material which will inhibit the action of the acid.

"The Court: There is no claim that the acid, for instance, in this well, would not have done just as good a job as if it had not gone into it—

"A. I do not believe so.

"The Court: They do not claim any new useful result. They just claim to have avoided a misfortune.

"A. The useful result would be limited apparently to the equipment, rather than to the well itself.

"The Court: As far as increasing the flow of the well, and all of that, they do not claim to have accomplished anything?

"A. I don't think so.

"The Court: But simply to have avoided a misfortune?

"A. I think so. Inhibitors, such as are suggested here, as far as I know, would have no effect on the acid, in connection with its reaction upon limestone.

"The Court: All right. In other words, it has absolutely,—the adding of this has no effect that we know anything about or claim anything about on the work which is desired to be done in treating the well?

"A. That is my understanding. But it does have a specific function on the metal equipment used in connection with the well treatment." [R. 323-4.]

No such admission was made by plaintiff in the *Williams Bros.* case.

The only reference in the Grebe & Sanford patent to the strength of the aqueous hydrochloric acid solution is

in connection with its corrosive action upon the metal of the well equipment.

> "The strength of the aqueous hydrochloric acid solution, in general best adapted to the purpose in hand, may be between about 5 per cent and about 20 per cent, and preferably should be between 10 and 15 per cent although other concentrations may be used, if desired. *With such strength of acid the corrosive action thereof upon metals, particularly iron or steel, can be largely or substantially inhibited by adding thereto a relatively small amount of an arsenic compound or other inhibiting agent. Consequently, the acid can be introduced into the well through the pump tube, so that the latter need not be withdrawn prior to the treatment.* It is sufficient merely to pull the pump rod and valves, and to pour the acid solution into the well through the tube. Due to the presence of the inhibitor there will be no substantial attack upon the pump tube, or upon the well casing if the charge of acid rises high enough in the well to contact with the casing." [R. 1502, lines 7-29]*

It is clear that this text contains no reference whatsoever to any difference (either in manner or kind or even in degree) in the operative effect between stronger and weaker acid in dissolving the limestone formation. The patent makes no reference whatsoever to any difference in the manner or even in the degree of dissolving the limestone formation, which difference is in any manner asserted to be dependent upon the use of stronger or weaker acid.

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*Throughout this Brief emphasis supplied by us, unless otherwise indicated.

The thesis of the patent is the use in the acid of an inhibiting agent to control the corrosive action of the hydrochloric acid upon the metal parts of the well equipment. By expert testimony, [R. 1365, 1368 and Exhibit 343, R. 1802] plaintiff attempted to develop the difference in degree of corrosive action upon steel between relatively stronger and weaker hydrochloric acids. This testimony stresses the fact that with more dilute acid the corrosion rate was less than with stronger acid. This testimony was obviously produced by plaintiff to support the thesis of the patent, *i. e.*,– that the object of the invention was to protect the well equipment from injury.

Nor did the plaintiff assert to the Patent Office that the function of the acid in dissolving limestone differed either in manner or kind or in degree dependent upon the strength (dilution) of the acid. In plaintiff's petition to The Commissioner of Patents for special immediate consideration of the Grebe & Sanford application, it represented that "The feature of the method consists in the use of a prepared acid *which does not attack and corrode metallic pipes, valves, pumps and other parts of well equipment.*" [R. 2021.] Following a rejection of the application, plaintiff filed an argument giving its reasons why the patent should be allowed. This argument was in great detail. It covers over ten printed pages of the record herein [R. 2027 to 2038]. In this argument plaintiff did not contend that the strength of the acid was in any manner critical so far as its action in dissolving the limestone or well formation was concerned. No reference was made to dilute acid. Not a word was said in this argument that the success of the method in dissolving the limestone formation depends upon dilution of

the acid. *Invention was urged as existent in the inhibition of the acid against corrosion of the metallic equipment of the well.*

The Record Conclusively Establishes and the Sixth Circuit Court Found That

> "It was old to increase production by the use of hydrochloric acid under pressure." [R. 2059].

The Frasch patent and the Oil City Derrick October 10, 1895 publication [R. 1651] made a part of the public knowledge the fact that the introduction of hydrochloric acid under pressure into the cavity of an oil well would dissolve the limestone formation, increase its porosity, and open channels in it to permit the oil to flow into the well cavity.

The record establishes that in *1895* and *1896*, Herman Frasch and John W. Van Dyke successfully, publicly and commercially treated limestone formations of oil wells near Lima, Ohio, and increased the production thereof, by pumping dilute commercial grade hydrochloric acid into the well formations [PX[1] 93 – R. 1651; PX 144 – R. 1657; PX 145 – R. 1658; PX 146 – R. 1659; PX 148 – R. 1661; see also the testimony of Nichols, an eye witness, R. 1030 *et seq.*; Irish, R. 1040; Neubauer, R. 1057; *Cf.* F. F. 71 – R. 1488-9]. The pipe used to conduct the acid down the well was coated [R. 1044] to protect it from the corrosive action of the acid. PX 93 is a reproduction of an article published Oct. 10, 1895 in the

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[1]The exhibits of the respective parties were marked consecutively, those of the plaintiff being identified as "PX"; those of the defendant, as "DX".

"OIL CITY DERRICK," which PX 142 [R. 1656] states is "The most valuable existing record of development of the petroleum industry in the United States. Special attention to markets, field operations, and production." Its publication began Jan. 14, 1876.[2] Under the provisions of R.S. *4886 (35 USCA, Sec. 31)* this printed publication made, as of Oct. 10, 1895, the process or method of treating limestone formations of oil wells with hydrochloric acid a part of the public knowledge. The method as published in this article differs from the disclosure of the Grebe & Sanford patent only in that the described operation consisted in using one-inch tubing to conduct the acid below the casing of the well, the one-inch tubing being coated so that the acid would not affect it [R. 1044, 1049, 1050, 1884, 1890], while the Grebe & Sanford operation consists in using hydrochloric acid solution into which has been introduced an inhibiting substance. The purpose and result of using such coated tubing, or its substitute (an inhibiting substance added to hydrochloric acid), is the same, to wit: to protect the tubing or pipe through which the acid is introduced into the well cavity below the casing, where the limestone formation is to be subjected to the action of the hydrochloric acid. This article states that: –

> "Two months ago, a practical test of this process was made on a well on the Crossley farm, owned by the Ohio Oil Company, near Lima, Ohio. There were 65 barrels of acid used in the well on the Crossley farm. The channels in the oil rock in this

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[2]Plaintiff's counsel, Mr. Owen, stated: "The Oil City Derrick, I understand, was the leading publication in the oil industry way back at that early date." [R. 1194A].

well, were so tight that even with a pressure of between eight and nine hundred pounds per square inch, the rock would take barely a barrel of acid and water per hour.* However, as the acid began to perform its work, the channels in the rock were gradually increased so that at the finish the rock would readily take up six barrels per hour.

"Since doctored, this well has been pumped some 40 days. The oil was increased 300 per cent, and the gas over 400 per cent. The increase has been permanent as the well is holding up." [R. 1653-4.]

The record contains no testimony produced by plaintiff contradicting any of the facts respecting Frasch & Van Dyke's successful public commercial use of such process. Anyone, having before him the "Oil City Derrick" article of Oct. 10, 1895, would be taught thereby that by treating an oil well with hydrochloric acid to dissolve or eat the limestone formation the well's production would be increased.

Frasch's Method Was Successful in Its Use.

There was no evidence whatsoever before the Court in the *Williams Bros.* case respecting any use or attempted use by Frasch. The record herein is replete with such evidence. The District Court found as a fact that the method disclosed in the Frasch patent "was success-

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*Since, in the initial part of the treatment the rock took "barely a barrel of acid and water per hour," it is apparent that the acid was not used full strength. Contrary to the assertion, (Dow brief, p. 43) that since Frasch's time nobody has ever tried to use concentrated acid, Sprenger used such acid in 1932 and got good results [R. 1257, 1258].

fully used on a commercial basis in the acidizing of a number of wells near Lima, Ohio, in 1895." [F. F. 71 – R. 1489]. The Sixth Circuit Court of Appeals affirmed this finding and amongst other things said of Frasch: "His essential conception was to attack the limestone rock with a chemical reagent which would disintegrate the rock, increase its porosity, and open the channels into the pay. In this he fully succeeded." [R. 2055-6].

Plaintiff asserts that the work done by Frasch was not a commercial success. The record proves otherwise. It is shown by oral testimony [R. 1032, 1035, 1042, 1044, 1045, 1060] and by records [R. 1884-1907; DX 72-138] that a number of wells were treated and the production materially increased. The record contains references to the following wells so treated by Frasch and Van Dyke:

Well	Result of Acidizing	
	Production Before	Production After
Crossley #3 [R. 1894]	1.6 bbl/day [R. 1894]	Increase 300% [R. 1654]
Arnot [R. 1891]	11 bbl/day	16 bbl/day [R. 1658]
Neely #1 [R. 1890]	7 bbl/day	17 bbl/day [R. 1660]
Mary Richards #1 [R. 1895]	3 bbl/day	12 bbl/day [R. 1660]
Taylor [R. 1897]	5 bbl/day	35 bbl/day [R. 1657]
Cusac #2 [R. 1897]	4 bbl/day	4 bbl/day [R. 1658]
Presser #4	7-1/2 bbl/day	20 bbl/day [R. 1660]
Metz #1	2-1/2 bbl/day	11 bbl/day [R. 1658]
Hydecker #1	3 bbl/day	6 bbl/day [R. 1663]
Tinsley #1	1-2/3 bbl/day	14 bbl/day [R. 1663]
Beyham #5	2 bbl/day	45 bbl/day [R. 1662]
O'Connell #1	6-1/2 bbl/day	20 bbl/day [R. 1662]

These increases in production are comparable to increase of production of wells of similar capacity treated by defendant's operations. Defendant is charged with infringement in treating three wells for the Weber Oil Company. Of these, the Stella Wilcox well was producing about twelve barrels per day before treatment. After treating with acid "production was increased probably by two thirds for at least thirty days." [R. 302.] The Zahn well

was increased from 5 or 6 barrels a day to 10 or 15 barrels per day [R. 303]. The Crawford well was not pumped long enough after treating to find out if it was improved [R. 303-304].

Although these early wells were small judged by the present day standards, in most cases Frasch's treatments resulted in increased flow of oil [DX 144-5; R. 1657, 1658]. The method was tried upon some dry holes. No production of oil was thereby secured. The method was not one to make oil, and oil cannot be produced where it does not exist. That the use of the process was carried on by Frasch for nearly two years is proven by sundry articles published in the Oil City Derrick [DX 143-149; R. 1656-1663]. That this work was on a commercial basis [R. 1043] and was successful is shown by the fact that it was paid for by the owners of the wells [DX 109; R. 1896-1900]. On July 25, 1895, Frasch and Van Dyke solicited an opportunity to treat a well for the Ohio Oil Company. The letter of Van Dyke to Mr. Lufkin was a proposition that the Ohio Oil Company furnish Frasch and Van Dyke "a well comparatively new, reasonably free from salt water and in producing territory, by this I mean to convey to you that we want an oil well which there would be a chance of improving with our method; we do not want a dry hole, or a well in such a condition that nothing would improve it," and that Frasch and Van Dyke would treat the well at their expense and if the flow of the well was sufficient to warrant Ohio Oil Company paying Frasch and Van Dyke for their material, this should be done and Mr. Lufkin was to be the judge [R. 1896, DX 109] [*cf.* DX 110; R. 1900-1]. A well was furnished and it was suc-

cessfully treated and payment made under the agreement [*Cf.* R. 1897-1900].

Frasch and Van Dyke treated other wells for the Ohio Oil Company [R. 1657, 1658, 1659-60, 1898-1900].

The mere fact that operations were discontinued by Frasch and Van Dyke does not prove their operations were unsuccessful. Nor does it constitute an abandonment of an invention within the meaning of *R.S. 1886, 35 U.S.C.A., Sec. 33.* On the contrary, this was a use by others in this country before Grebe and Sanford's alleged invention. There was little use for this method at that time. "There weren't many important limestone fields in Ohio, outside of the Trenton field in Northwestern Ohio." [Plaintiff's witness Fitzgerald – R. 179]. The record evidence in this case proves successful use. There is no conflict in the evidence. Such prior use and such prior knowledge is proven by the records. Frasch and Van Dyke's operations were personal to them and not a part of the interest of any producing company. Insufficient financial return to them to warrant their continued use of the process can form no basis for a contention that the process was not successful or that Grebe and Sanford were the first discoverers of such process. It is a notorious fact that modern wells are greater producers of oil than those in 1896. However, many wells today are not benefited by this treatment [R. 37, 194, 195]. The testimony of Mr. Irish, [R. 1040-1052] a business associate of Mr. Van Dyke's, who was with him in Ohio at the time of these treatments and associated with him all during Mr. Van Dyke's business life, discloses that Mr. Van Dyke became interested in a paper mill at Middleton, Ohio, and had other large interests

which he was developing and carrying on, [R. 1045] and moved to Philadelphia, and that Mr. Frasch was developing and carrying on the mining of sulphur in Louisiana [R. 1046].

The Frasch Patent.

On *June 27, 1895*, Frasch filed an application for patent upon this method of increasing the flow of oil wells. On March 17, 1896, patent 556,669 was granted to Frasch and Van Dyke [R. 1935-8]. The application for this Frasch patent proves that approximately four months before the publication of the Oct. 10, 1895 Oil City Derrick article, Frasch had constructively reduced his invention to practice. By this patent Frash and Van Dyke were granted the exclusive right to use "The method of increasing the flow of oil-wells in limestone formations, by introducing into the well a large quantity of a chemical reagent which is a solvent of the rock (such as hydrochloric or muriatic acid), and subjecting such reagent to strong pressure; substantially as described." [claim 4 – R. 1937]. The Frasch patent recognizes that means might be provided for protecting the pipe against corrosion. It states [*ll. 27-30*, R. 1937], "It may be enameled or lead-lined pipe * * * or it may be otherwise made proof against corrosion." Upon March 17, 1913 all residents in this country acquired (by the expiration of the patent) the common, free right to use such method.

The Grebe & Sanford patent states that a chemical method is described in this Frasch patent "according to which the flow of an oil well in a limestone formation is increased by treating with a quantity of an acid, such as hydrochloric acid. The acid has the effect of attacking and

dissolving the rock, thereby enlarging the cavity at the bottom of the well, or the channels and pores in the rock through which oil flows to the well." [R. 1501, *ll.* 43-52.] Grebe and Sanford in their patent do not assert that the information given in this Frasch patent is not fully sufficient to enable one skilled in the art to increase the flow of an oil well, which well is in a limestone formation and in which formation there exists potential oil production.

The Frasch patent states that "By using enough acid and pressing it back into the rock long channels can be formed and oil reached thereby which otherwise could not be had without drilling other wells, if at all." [R. 1936, *ll.* 54-58.] It explains the action of the hydrochloric acid as attacking and dissolving the rock, "or, in other words, forms a soluble compound of calcium, such as the chloride, for example." [R. 1936, *ll.* 63-65.] It states that "By the use of a chemical reagent which forms a soluble salt of calcium the products of the chemical decomposition of the lime stone are removed with the liquid in which the salt of calcium is dissolved, and which conveys the same from the remotest points. The channels which have been cut in the rock are thus left free, thereby securing the maximum increase of the flow of oil as well as of the oil-holding capacity of the well." [R. 1937, *ll.* 6-15.] It further discloses that "When as much acid as desired, say one thousand gallons, has gone into the rock, a force-pump is connected with the pipe A and fresh water is forced down to displace the acid in the pipe and rock, and by forcing it still farther into the rock extend the area of its action." [R. 1937, *ll.* 49-55.] It recommends leaving the acid in the well for twelve hours [R. 1937, *ll.* 55-60]. The method

claimed (claims 4, 5, 6 and 7) includes subjecting the acid in the well to strong pressure to force the acid farther into the rock. It states that: "It is an advantage to confine the reagent outside the supply-pipe to the lower or oil-yielding portion of the well-hole. This can be done by a suitably-arranged packer which shuts off the lower from the upper portion of the hole and prevents the reagent from ascending above the packer." [R. 1936, *ll.* 40-46.] It recommends the use of muriatic or hydrochloric acid which contains from 30% to 40% by weight of the acid gas HCl [R. 1936, *ll.* 66-70].

The Record Conclusively Establishes and the Sixth Circuit Court Found That

> "It was old to use inhibitors with hydrochloric, phosphorus and other pickling acids to reduce corrosion on iron and steel." [R. 2059, *Cf.* Findings of Fact Nos. 65, R. 1487 and 73, R. 1489].

Thirteen years after the grant of the Frasch patent, Jay C. Beneker (in *1909*) was granted patent 914,916 [R. 1941]. Beneker's patent discloses the inhibition of hydrochloric acid by the addition thereto of arsenic compounds [*Cf.* R. 916].

In *1923*, Harry N. Holmes was granted patent 1,470,225 [R. 1945] for the use of inhibited hydrochloric acid as a limestone solvent under conditions where there would be corrosive action of the acid on metal, such as pipe, if raw commercial acid were used. The particular use disclosed by Holmes is the removal of scale (such as boiler scale or the like) from boiler sheets or tubes. "Now, the meaning of that boiler scale is a deposit that is left by the evaporation of water in the boiler, and it consists usually

of calcium and magnesium salts, and often is not very far in composition from the composition of rock found in oil wells, or of common limestone. Therefore, the problem of freeing the boiler from boiler scale, or the boiler tubes of the boiler from boiler scale is very analogous to the problem of the patent in suit. You want to dissolve some type of limestone-like formation by means of acid which has to be transported in steel. In this case, one wants to remove the undesirable encrustation from the steel boiler without harming the boiler, and it is that particular analogous application for which I think this patent is most interesting." [R. 916-17.]

In 1923, the American Chemical Paint Company (James H. Gravell, President) commenced the manufacture and sale of a "pickling compound" called "Rodine" [R. 898-901] consisting of hydrochloric acid to which an arsenic compound and other agents were added as inhibitors [R. 899, 901-06], the pickling compound being stored and transported in steel drums [R. 908], and the inhibition of the acid protecting the steel drums against the corrosive action of the acid. "The Court (interposing): —The real purpose of this was to fix it so you could transport it? A.—Yes, sir." [R. 907] "I know that this material had been reduced to a commercially feasible product and had actually been tested in practice at some time before that date." (Oct. 29, 1924) *(Id.)* Mr. Douty, Chief Chemist of the American Chemical Paint Company, further testifies:- "Q.—You couldn't find any record of the sale of inhibitors in this country or the existence on the market of inhibitors prior to what date? A.—Well, as a matter of fact, I don't think that there was a commercial inhibitor sold in this country before 1920." [R. 927].

In acidizing oil-wells it has been the regular practice of plaintiff to use this Gravell method of transporting acid [R. 130-1, 132, 1149-50] *cf.* F.F. 53, 54 – R. 1484.

On *December 11, 1925,* James H. Gravell, president and founder of American Chemical Paint Company [R. 897], filed application for letters patent upon "The method of preventing an acid solution from attacking a steel transportation or storage drum containing it which consists in dissolving in the said acid solution a material capable of precipitating a substantial protective coating on steel, and allowing the admixture to contact with the inner steel surface of the drum." [claim 1 – R. 1948]. Patent 1,678,775 on this application was granted July 31, 1928 [R. 1947]. Claim 4 of this patent defines the method as consisting "in admixing with the said acid solution arsenic compound and organic bases, and allowing the admixture to contact with the steel drum." [R. 1948-9], and claim 7 defines the invention as "A composition of matter for preventing the action of acid solutions on steel drums consisting of an admixture of arsenic compound and organic bases." [R. 1949]. This patent states: "However, if arsenic trioxide is added to the material substantially as follows

Organic bases	.25	gals.
Hydrochloric acid	.75	gals.
Arsenic trioxide (As_2O_3)	.125	bbls.*

the material may be shipped and stored in steel drums due to the protective coating formed, precipitated or deposited on the inner surface of the drum. Although arsenic plates

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*"bbls." should be "lbs." – R. 1362.

out, the organic bases are not affected sufficiently *to make any difference in the commercial use of the material.*" [R. 1947, *l.* 85—R. 1948, *l.* 13]. Here this Gravell patent discloses to the world that the presence of the arsenic trioxide or the presence of the organic bases does not affect the hydrochloric acid in the effective use which is to be made of the acid. Of this quoted statement, plaintiff's expert Alquist says: "I would take that to mean if he had the organic bases and the acid, that the arsenic would plate out of that particular mixture, and that that did not interfere with the use of the material later. That is what I take it it means." [R. 1362].

The Gravell* patent does not limit its claim or disclosure to any particular use to be made of the inhibited hydrochloric acid. The patented invention is a method of *transportation* or storage of such acid. Running the Gravell inhibited acid down through the oil-well casing or tubing is transporting it to the bottom of the well. Plaintiff's expert Prutton says:— "Then for transporting it, that is, conduit through which we can run the acid, we have glass tubing, such as Pyrex glass; we have rubber-lined steel pipe; we have ordinary rubber hose; we have

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*In this suit defendant counterclaimed on this patent. It was adjudged invalid [R. 1492]; defendant did not appeal. The inhibited acid of this Gravell patent enabled its transportation to the well in ordinary steel tanks. The tanks are used to haul acid every day and on each trip it is normally necessary to have the acid in them for many hours while loading, hauling or waiting at the well. Prevention of corrosion of the tanks is important. The pipe in a well, however, is subjected to contact with the acid only during the time the acid is being pumped down the well. This time is relatively short. In treating the three wells relied on herein to prove infringement, the acid was in contact with the pipe 8, 25 and 145 minutes, respectively [R. 773]. The amount of corrosion during such periods of contact is negligible [R. 462, 463, 659, 660]. When plaintiff started acidizing wells, it used steel tanks [*cf.* R. 1149, 1150].

Hovag piping, or Bakelite piping; we have hard rubber pipe, and those are the principal conduit materials that are used in transporting hydrochloric through a conduit." [R. 1145]. In the Grebe & Sanford patent the purpose of these inhibiting substances is to prevent the acid from dissolving the metal surfaces ("iron or steel, copper, etc.") while substantially the full power of the hydrochloric acid is retained to dissolve limestone. The proportions of hydrochloric acid and arsenic trioxide, set forth in this Gravell patent quoted example or formula, are the same as the proportions of hydrochloric acid and arsenic trioxide given in the Grebe & Sanford patent, to wit: "The amount of arsenic compound added may be varied, but we have found that from 1 to 5 per cent thereof, based upon the weight of the solution will be satisfactory for the purpose." [R. 1501, *ll.* 84-8].

The Addition of a Corrosion Reducing Agent to the Acid Produced No New Result: It Did Not Change the Effect or Manner of Dissolving the Limestone Formation: It Merely Substituted One Known Means for Reducing Corrosion of the Metal Equipment of the Well for Another Known Means. This Was Not a New Process. No Invention Was Involved.

The Record Conclusively Establishes and the Sixth Circuit Court Found That

"The only novel element here was that applicant first charged the inhibited hydrochloric acid into the limestone formation through the pump tube. The application of these two old principles to an oil well and the obvious step of conditioning the acid through the pump tube did not constitute invention in view of the prior art used in this case. All that was re-

quired or expected was mechanical skill. No new result was achieved." [R. 2055, *Cf.* Findings of Fact Nos. 76, 77, 81, R. 1489-90.]

It is an admitted fact in this case that the so-called inhibiting agent has only its old purpose and effect, of reducing the corrosiveness of the acid incident to its contact with the metal parts; that it has no effect upon the action of the acid in dissolving the limestone in the well formations. The inhibiting agent is solely for innibiting or reducing the corrosion incident to the acid passing or coming in contact with the metal parts. "'Merely bringing old devices into juxtaposition, and there allowing each to work out its own effect without the production of something novel, is not invention. No one by bringing together several old devices without producing a new and useful result, the joint product of the elements of the combination and something more than an aggregate of old results, can acquire a right to prevent others from using the same devices, either singly or in other combinations, or, even if a new and useful result is obtained, can prevent others from using some of the devices, omitting others, in combination.' Hailes v. Van Wormer, supra. (20 Wall. 353, 368)." Having quoted this statement of this general principle (247 US 426, 432-3), this Court in *Grinnell Washing Mach. Co. v. Johnson Co.* proceeds (Id. p. 434), to further clarify it:- "Applying the rule thus authoritatively settled by this court, we think *no invention* is shown in assembling these old elements for the purposes declared. No new function is evolved from

this combination;' the new result, so far as one is achieved, is only that which arises from the well-known operation of each one of the elements." *Germer Stove Co. v. Art Stove Co.*, 150 F. 141, 145 (C.C.A. 6), applied this rule of want of invention, saying:– "Germer has done no more in his first claim than to unite the Condit fire pot with a grate in which the amount of air might be controlled by a damper. There is nothing new in his fire pot, for it is the fire pot of Condit. There is no invention in his grate, for grates in which the supply of air may be regulated were not new. The claim covers a mere aggregation of elements, the fire pot and the fire grate each producing its own effect after as before the combination, each operating in the combination as it did before. The mere bringing together of old parts and allowing each to work out its own old effect, without producing some new product or result as a consequence of the union and co-operating action, is a mere mechanical juxtaposition. Goodyear Tire & Rubber Co. v. Rubber Tire Wheel Co., 116 Fed. 363, 370, 53 C.C.A. 583; Overweight Counterbalance Elevator Co. v. Henry Voight Mach. Co., 102 Fed. 957, 43 C.C.A. 80." It is undisputed in this case that mixing arsenic trioxide or other inhibiting agent with hydrochloric acid is solely for the purpose of reducing the corrosive effect of the acid upon the metal parts; that there is no new or theretofore unknown action or result produced or secured through such mixture. Two old results are secured when such mixture is transported in steel drums to the well and down through

the metallic pipe to the cavity at the bottom of the well. These are: *1st*, the amount of corrosion of the metal parts is reduced or controlled; and, *2nd*, the limestone at the bottom of the well is dissolved. The reduction of corrosion of the metal parts is separate and distinct from any dissolution of the limestone formation, and neither is affected by the other.

In *Grosjean v. Panther-Pánco Rubber Co.*, 113 F. 2d 252 (C.C.A. 1), the Court had before it a patent upon a process or method defined in claim 1 of the patent (113 F. 2d at 254). This claim was held invalid for want of invention, the Court saying: "The patentee discloses here an aggregation of old and known steps to construct soles substantially similar to those already known in the art. Such an aggregation is not patentable when no new and useful result is produced and mere aggregation is not invention either in processes, machines, or manufactures. (Walker on Patents, Deller's Ed., Vol. 1, Section 42, p. 218.) What the patentee actually did here was to use old devices for analogous purposes. This is not invention. (Walker on Patents, Deller's Ed., Vol. 1, Section 43, p. 226 and cases cited.) The aggregation did not perform nor produce any new or different function or operation than the elements that composed it had already performed or produced. Cf. Lincoln Engineering Co. v. Stewart-Warner Corp., 303 U.S. 545, 549, 58 S. Ct. 662, 82 L. Ed. 1008; Tropic Aire, Inc. v. Cullen-Thompson Motor Co., 10 Cir., 107 F. 2d 671, 673. Each of the steps disclosed here reflects a function previously performed

There is no joint function performed to produce a new result, as the plaintiffs contend in their brief that would make the aggregation patentable. The court stated in Hailes *et al.* v. Van Wormer *et al.*, 20 Wall. 353, 372, 87 U.S. 353, 372, 22 L. Ed. 241, 249, and it is applicable here: 'No new operation is given to it by the combination * * * Each [device] produces its appropriate effect unchanged by the others. That effect has no relation to the combination; in no sense can it be called its product.' Bauer Bros. Co. v. Bogalusa Paper Co., 5 Cir., 96 F. 2d 991, 994, 995."

Cf. *Weir Frog Co. v. Porter*, 206 F. 670, C.C.A. 6; *Kellogg S. B. & S. Co. v. Michigan Bell Tel. Co.*, 99 F 2d 203, C.C.A. 6; *Ranco, Inc. v. Gwynn*, 128 F. 2d 437, C.C.A. 6; *Fort Pitt Supply Co. v. Ireland & Mathews Mfg. Co.*, 232 F. 871, 874, C.C.A. 6.

The situation here is clearly comparable. The Frasch patent recorded and thereby made public for all time the fact that hydrochloric acid used to dissolve the limestone formation of oil-wells would increase production; it was also common public knowledge that hydrochloric acid would attack metal, including the oil-well casing pump tubing and metal parts in the well, and it was also public knowledge that this corrosive action of the acid upon such metal parts could be reduced or inhibited by the use of arsenic trioxide and by each and every one of the "Other inhibitors" mentioned in the Grebe & Sanford patent. The principle applied in *Oxford Varnish Corp. v. General Motors Corp.*, 120 F 2d 44, 47 (C.C.A. 6),

applies equally here:— "A combination of old elements does not secure a patentable process because it produces a refined or improved result unless the new result is attained in a new way."

Plaintiff here stresses the fact that it was the first to use inhibited acid to dissolve limestone formation in an oil well. As to the inhibition of the acid it admitted that its sole purpose was to reduce "the attack of the acid upon metal surfaces," – the well equipment; that in the performance of dissolving the limestone formation the acid was unaffected by the presence of the inhibitor [R. 323-4]. It is an established fact that the use of hydrochloric acid to dissolve limestone formation was presented to Grebe and Sanford by the Pure Oil Company. The fact that some of plaintiff's technicians had theretofore had knowledge of and used inhibitors in hydrochloric acid, cannot assist plaintiff in attempting to support patentable invention. This is well expressed in *Bauer Bros. v. Bogalusa Paper Co.*, 96 F. 2d 991 *(supra)* wherein the Fifth Circuit Court of Appeals had before it a patent upon a method or process and said, at p. 995: "It is interesting to note that, as the patentee under number 1,711,706 went about his scientific study of the structure of wood and its responses to various stresses and strains, he found machines already manufactured with which to test his theories and demonstrate his discoveries. With the aid of the knowledge thus obtained, he was able to assemble these machines into the aggregation described, but this does not prove invention. He may have contributed to the

useful knowledge bearing on the art, but even this does not prove novelty within the patent laws, since he was merely explaining phenomena familiar to the art. Indeed some of the greatest contributions of useful knowledge are outside the operation of patent laws, since they do not amount to invention or discovery of any art, machine, manufacture, or composition of matter. In the language of the patent law, a process is an art. Cochrane v. Deener, 94 U.S. 780, 788, 24 L. Ed. 139."

It having been known to the public, long prior to Grebe & Sanford, that agents such as arsenic compounds and organic bases could be put in hydrochloric acid to inhibit or prevent action of the acid on iron, no invention was involved in putting such agents in hydrochloric acid for use in the Frasch process. To do so does not constitute a new process. It is merely the substitution of one known agent for another in the old Frasch process. *DeLamar v. DeLamar Min. Co., Ltd.*, 117 F. 240 (CCA 9); *Farrell v. Boston & M. Consol. Copper & Silver Min. Co.*, 121 F. 841; *Baker v. F. A. Duncombe Mfg. Co.*, 146 F. 744 (CCA 8); *James Brown et al. v. Enoch Piper*, 91 US 37; *King v. Gallum*, 109 US 99; *Lovell Mfg. Co., Ltd. v. Alanson Cary*, 147 US 623. Grebe and Sanford only adopted means equivalent to that suggested by Frasch for protecting pipe against corrosion. "There was no invention . . . in substituting one known material for another in the same or an analogous art. Firestone Tire & Rubber Co. v. United States Rubber Co., 6 Cir., 79 F 2d 948." (*Paine & Williams Co. v. Baldwin Rubber Co.*, 113 F. 2d 840, 844 – CCA 6.)

Dilute Acid.

Hydrochloric *acid* is hydrogen chloride *gas* (HCl) dissolved in water.[1] In industrial use, the acid is commonly used at less than full strength. If stronger than 20% it gives off dangerous fumes.[2]

One of the common uses of hydrochloric acid is to clean metals. *General Chemistry for Colleges*, page 147. When used for this purpose, the commercial or muriatic acid is usually diluted. The patent to Beneker No. 914916 [R. 1941], granted March 9, 1909 on "Wire and Metal Cleaning Bath" states: "In the *usual* process for cleaning or pickling, the wire, rods or black sheets are subjected to the action of a *dilute* solution of sulfuric or hydro-chloric acid." [R. 1941, *ll.* 11-14].

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[1] "Hydrogen chloride is a colorless gas which produces a suffocating effect when inhaled. . . . On account of its great solubility, when it streams into the air it condenses atmospheric moisture into a fog of drops of hydrochloric acid." *General Chemistry for Colleges*, by Alexander Smith, 2nd Edition 1916, The Century Co., Page 144. Commercial hydrochloric acid is commonly called muriatic acid. "The ordinary muriatic acid of trade is an aqueous solution of the acid vapor, having a specific gravity of about 1.20 and containing about 40 per cent by weight of dry hydrochloric acid vapor. It is impure, containing sulphuric acid, chlorine, iron chloride, arsenic and generally lead and calcium chlorides." *Outlines of Industrial Chemistry*, by Thorp and Lewis, 3rd Ed., MacMillan Co., 1917, Page 91.

[2] "Hydrochloric acid weaker than 20 per cent does not fume when in contact with moist air while the stronger acid gives rise to dense white fumes which consist in droplets of hydrochloric acid. The reason for this is that the hydrogen chloride given off from the strong solution is capable of uniting with water vapor in the air to form a solution having a smaller vapor pressure than the original solution, and therefore droplets of this solution are formed and constitute the fumes." *Inorganic Chemistry*, by Cady, 1st Ed. McGraw-Hill Book Co., 1912, Page 128.

The patent to Holmes,[3] No. 1,470,225 [R. 1945], granted October 9, 1923 for "Removal of Scale and Rust from Iron and Steel," deals with the removal of "boiler scale" [limestone deposits, R. 916] by the use of inhibited acid. The patent states:– "Hydrochloric acid solutions can be used in various strengths, for example, one volume of commercial concentrated acid to one volume of water, the inhibiting effect being maintained at the higher temperature noted." [R. 1945, *ll.* 93-97]. Since commercial acid has a strength of 30 to 40%, the solution mentioned by Holmes would be a 15 to 20% "aqueous hydrochloric acid solution."

Prior to Grebe & Sanford's alleged invention the Dow Chemical Company had been using the Holmes (patent 1,470,225) process in removing scale [limestone deposits, R. 916] from tubes in its plant [R. 1421]. The Dow Laboratory at that time had made tests to determine the effectiveness of arsenic compounds as inhibitors in hydrochloric acid ranging in strength from 4 to 22% [R. 1423]. The results as tabulated in the report,[4] [R. 1423], two years prior to Grebe & Sanford's alleged invention, show the inhibitor in reducing corrosion is not nearly as effective if a 22% solution is used as when a 15% solution is used.

Commercial hydrochloric acid is 70% water. The Grebe & Sanford patent refers to an aqueous solution

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[3]Harry N. Holmes, Professor of Chemistry at Oberlin College.

[4]"Mr. Owen: This is offered to show that when this oil well problem came up Grebe had this information regarding the efficiency of arsenic as an inhibitor. The Court: Dissolving rock, you say? Mr. Owen: No, dissolving scale. * * * Mr. Owen: Yes. It brings to Grebe specific knowledge of the efficiency of arsenic as an inhibitor. They weren't doing anything new." [R. 1421, 1422].

"between about 5 per cent and about 20 per cent." [R. 1502, *ll.* 1-10]. Such a 20% solution would contain 10% less HCl and 10% more water than this aqueous solution referred to in the Frasch patent. It would contain from 7% to 8% less HCl than the 27% to 28% HCl "actually used in his (Frasch) first treatment." (Dow brief, p. 36).[5]

Nothing in the Grebe & Sanford patent would teach one skilled in the art that the degree of dilution of the acid was a critical factor to its successful operation in dissolving the limestone formation of an oil well. At the trial *the difference in corrosion* of metal by different dilutions of hydrochloric acid was the subject of much expert testimony on behalf of plaintiff, but no testimony was pre-

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[5]Plaintiff's statement is based on defendant's Exhibit 90 [R. 1889] 27% to 28% acid was shipped by the Grasselli Chemical Company. This exhibit does not state that this acid was used without further water (dilution). The Frasch patent states the acid ("re-agent") is displaced and caused "to penetrate farther into the rock for forcing a neutral or cheap liquid, such as water, into the well, * * *." [R. 1936, lines 83 to 86]. And that "When as much acid as desired * * * has gone into the rock, a force-pump is connected with the pipe A and fresh water is forced down to displace the acid in the pipe and rock, and by forcing it still farther into the rock extend the area of its action." [R. 1937, *ll.* 49-55].

In the *Oil City Derrick* of October 10, 1895 (Px. 93), there was published a description of the Frasch method as it was actually used. It is there stated:-

> "Large quantities of water are used with the acid so that the acid may be carried long distances, and the water be present to take up the rock when it is made soluble. Also the water being under great pressure, binds the carbonic acid gas in large quantities, and again liberates the gas to rush back through the long channels leading to the well, when the pressure is removed by starting the pump." [R. 1652].

sented for the purpose of establishing or explaining or which asserted any difference either in manner, effect, or degree in the dissolving of limestone formation in an oil well resultant from the use of Frasch's acid or plaintiff's 15% acid, or between any different strengths of hydrochloric acid.

The teaching of the Grebe & Sanford patent is merely that the addition of the inhibitor will prevent the attack of the acid upon the metal with which it comes in contact. The use of the more dilute acid is stated as preferred simply because the inhibitor can act more effectively with the weaker acid. This is because the more dilute acid is less corrosive. The strength of the acid is not critical and the patent does not assert that an acid outside the range from 5 to 20% will fail. In fact the patent states "other concentrations may be used, if desired." [R. 1502, *l.* 12]. The use of the more dilute acid, within the range of 5 to 20% strength, under these circumstances, cannot aid the patent.

A patentee is not permitted to arbitrarily select a point in a progressive change, and maintain a patent monopoly for all operations in that progressive change falling upon one particular side of an arbitrarily selected point. It is only when the selected point corresponds with some physical phenomenon, and the patentee has discovered the point at which the physical phenomenon occurs, that the maintenance of a patent monopoly is permissible. A patent claim must be based on an invention or discovery. If the invention depends upon the alleged discovery of certain limits or points, then no invention has been made if such points or limits do not exist in fact. This rule of law is illus-

trated in the following cases:– *General Electric Co. v. Cooper-Hewitt Co.*, 249 F. 69 (C.C.A. 6); *DeLamar v. DeLamar Mining Co.*, 117 F. 240, 248-9 (C.C.A. 9); *Lauman v. Urschel White Lime Co.*, 136 F. 190 (C.C.A. 6); *Bethlehem Steel Co. v. Niles-Bement-Pond Co.*, 166 F. 880, 883-5; affirmed 173 F. 1019 (C.C.A. 3); *Brady Brass Co. v. Ajax Metal Co.*, 160 F. 84, 89-90 (C.C.A. 3); *David Belais, Inc. v. Goldsmith Bros.*, 10 F.2d 673, 674 (C.C.A. 2); *Kwik-Set, Inc. v. Welch Grape Juice Co.*, 86 F.2d 945 (C.C.A. 2). The rule is firmly established in the decisions of the Court of Customs and Patent Appeals. See *In re Shoemaker*, 83 F.2d 288; *In re Arness*, 95 F.2d 344; *In re Britton*, 115 F.2d 249; *In re Lilienfeld*, 67 F.2d 920, 924; *Innis, Speiden & Co. v. Food Mach. Co.*, 49 Fed. Supp. 723, at 727.

The Grebe & Sanford patent does not state that Grebe and Sanford have found any difference either in kind or degree in the operative effect of more or less dilute or viscous hydrochloric acid in dissolving limestone formation in an oil well or in opening the channels or pores thereof or in displacing the viscous oil therein.

Viscosity.

Plaintiff's brief speculates between operative effects assumed by it to exist between the use of different viscosities of the acid. It states (1) that the more viscous acid would penetrate the rock more slowly under equal pressures (p. 19). The patent does not teach this. Plaintiff's brief states that (2) concentrated acid reacts more violently; that as this reaction proceeds the resulting solution becomes more or less viscous through the formation of calcium chloride which is taken up by the solution

(p. 19). There is no reference to this in the patent. The brief states that (3) the resulting viscous solution of spent acid would have to be forced back into the pores ahead of the unspent acid before those pores could be attacked and enlarged (p. 19), and (4) that the viscous spent acid solution would have to be forced out of the pores by the natural rock pressures before oil could pass through them into the well (p. 19). The patent contains no reference to any such action or effect. On the contrary, the patent states a preferred strength of the aqueous hydrochloric acid solution and says "With such strength of acid the corrosive action thereof upon metals * * * can be largely or substantially inhibited by adding thereto a relatively small amount of arsenic compound or other inhibiting agent." [R. 1502, *ll.* 13-18]. No other purpose is given in the patent for selecting any degree of strength of the solution or viscosity of the acid. Plaintiff's brief theorizes that the flow of the acid solution into the formation depends only on the viscosity of the acid: "Concentrated acid being about one third more viscous than the dilute acid of Grebe and Sanford, under equal pressures will flow at only two thirds of the speed of the dilute acid." (p. 37). There is nothing in the record to support this statement. No witness was examined upon any such question. Defendant denies the truth of this statement. The rate of flow into the formation must obviously depend just as much on the viscosity of the oil which must be displaced as on the viscosity of the acid. Moreover, the plaintiff's own Chamberlain patent 2,024,718* [R. 1512] sets forth that the effect of viscosity on the flow of acid

*This is one of the patents upon which this suit was originally based. The suit was dismissed as to this patent.

rebuts this contention. This patent mentions [R. 1512, *ll.* 36-44] three factors which affect the pressure required to move a chain of bubbles and liquid globules through capillary earth pores, these being the diameter of the bore, the surface tension of the liquid and the degree of adhesion. Viscosity is "internal friction" of the liquid itself. It is not mentioned in the Chamberlain patent. This patent shows that the pressure necessary to move a fluid in a capillary bore, under some conditions, can be reduced to one per cent merely by lowering surface tension and adhesion. [R. 1514, Col. 1, ll. 59-63.] This is definite proof that viscosity is a minor factor in determining the flow of hydrochloric acid solution into a formation. In fact, this shows that in some cases, at least, the surface tension is at least 100 times as important as the vicosity. It can readily be understood why the plaintiff could not advance the present theory of its brief with regard to viscosity in the lower court. It is completely contradictory to the theory which plaintiff did advance in that court in trying to uphold the Chamberlain patent.

HCl is miscible in water. The proportion of water in hydrochloric *acid* (HCl in solution) determines the viscosity of the acid. HCl gas is dissolved in water to form hydrochloric acid. The Oil City Derrick publication disclosed that "Large quantities of water are used with the acid so that the acid may be carried long distances, and the water be present to take up the rock when it is made soluble. Also the water being under great pressure, binds the carbonic acid gas in large quantities, and again liberates the gas to rush back through the long channels leading to the well, when the pressure is removed by starting the pump." [R. 1652].

"It is sometimes found, where the rock is close and the channels small, that additional pressure to that had from the hydrostatic column has to be employed, then a pump is used to press the acid back into the rock. In such wells, the acid will be driven into the rock very slowly at first, possibly not faster than a barrel per hour; however, as the acid begins to open up the channels, it is received more freely, and at the finish, it will take the acid and water at the rate of six or eight barrels per hour." [R. 1653].

The physical conditions in oil well holes are so variant that it is not possible to determine that where hydrochloric acid is brought into contact with the formation in the presence of water, or water mixed with oil of varying viscosity, its action in dissolving the formation would be substantially uniform as to modes of dissolution, effect, etc. In such an operation what is to prevent water pumped against the hydrochloric acid, *i. e.* HCl (a gas) dissolved in water, from further mixing and diluting the hydrochloric acid? Defendant denies plaintiff's assertions that there are in fact any differences in kind resultant from the use of a 30% HCl, 70% water solution and from the use of a 20% HCl and 80% water solution. Neither of the District Courts nor Courts of Appeals so found.

> "The statement of a process upon the part of a patentee, to be sustainable, must not only clearly distinguish the old from the new, so that the novelty claimed is obvious, but must point out the new steps so definitely, that one wishing to use that process for the production of the desired product, will have a clear chart before his eye."
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> *Cercaline Mfg. Co. v. Bates*, 101 F. 272, at p. 280, (C.C.A. 7).

At the trial plaintiff produced Dr. Prutton and J. W. Rebbeck to testify as experts. Plaintiff did not question either of them respecting any of these speculations and theories advanced for the first time in its brief. Neither was asked whether there was even a difference in degree, much less in kind, between the dissolving action on limestone formation of full strength commercial hydrochloric acid (30% HCl, 70% water) or Grasselli Chemical Company 27% to 28% commercial hydrochloric acid supplied to Frasch and referred to in Dow's brief p. 36 as "actually used by" Frasch "in his first treatment" and 5% to 20% aqueous solution of hydrochloric acid referred to in the Grebe & Sanford patent. At p. 38 Dow's brief states that the "Acid neutralizes itself quite quickly in the fine pores of limestone. * * * It is usually spent in an hour or less and the record shows one case where it was proved to be spent in 20 minutes" citing R. 203 and 284. The record does not support this assertion. The reference R. 203 is to a statement in an article by Mr. Chapman of the Chemical Process Company wherein, *inter alia*, it was stated:— "The well was allowed to be shut in 20 minutes awaiting chemical reaction." Plaintiff's attorney Mr. Owen objected "If it is for the purpose of cross-examining the witness, all right, but it doesn't prove the facts stated in the document." To which objection the trial court ruled: "I think that is right. It is more advertising by a third party." The reference R. 284 is to the testimony of Carl A. Nicholas (an operator for defendant), who at R. 278 stated: "The acid was forced into the well by application of pressure and the well closed in so that the acid could not come out of the well. I do not remember exactly how long the acid was allowed to remain

in the well, but it stayed there a few hours possibly." At p. 284 the witness does not state the acid is *"spent* in an hour or less."

Plaintiff's brief contains no substantial reference to the record as supporting its new theories. On page 18 of its brief plaintiff speculates as to evil consequences of using concentrated acid. Plaintiff's assertions made in the footnote respecting the amount of corrosion on tubing in a certain well are based purely on hearsay both as to corrosion and as to the use of strong acid. The reference to R. 232 is to a published article by Heithecker. This article was not admitted as proof of the facts therein stated. [*Cf.* R. 213, 214-15.]

From a technical or theoretical viewpoint there is every reason to believe that in so far as the reaction with limestone is concerned, hydrochloric acid of 30% concentration would produce better results than acid of 15% concentration. In support of this statement, we refer to "The Flow of Homogeneous Fluids Through Porous Media" by M. Muskat, Ph.D., Chief of Physics Division, Gulf Research and Development Company, Copyright, 1937, which we will hereafter refer to as "Muskat." This book is one of the International Series in Physics published by McGraw-Hill Book Company, Inc. It is perhaps the most authoritative of any on the subject of the flow of liquid in oil wells.

In considering the relative merits of 15% and 30% concentrations of hydrochloric acid in so far as the reaction on limestone is concerned, this book points out that the rate of flow of any acid through a filter bed involves what is known as Darcy's Law. In simple terms Darcy's Law states that the rate of flow of liquid

through the filter bed is proportional to the area of the bed through which the fluid flows, and is proportional to the pressure across the filter bed, and inversely proportional to the thickness of the filter bed or the length of the path of the flow of fluid. Muskat, Page 55. Darcy's law is subject to many variables. It holds true only in uniform homogeneous media. Obviously, if the rock is full of fissures or crevices or is anisotropic, the law does not prevail.

It is true, as stated on page 14 of plaintiff's brief, that acid of 30% concentration is slightly more viscous than a 15% concentration. The very slight difference in viscosity has no measurable effect on the speed with which the acid penetrates the rock. The viscosity affects the speed of penetration of the rock only in requiring more pressure to move the slightly more viscous fluid. It is quite possible that acid of 30% concentration enters a formation quicker and under less pressure created by the pump at the surface of the well than does acid of 15% concentration. Acid of 30% concentration has a higher density and weighs more than acid of 15% concentration, and in a deep well, at least, would exert a greater hydrostatic head of pressure than would acid of 15% concentration. This would cause the more concentrated acid to enter the rock faster. Actually, the viscosity of the acid does not affect the rate of flow into the rock. The viscosity of the *oil* in the formation affects the rate of flow of acid in the rock. No acid can flow into the formation without displacing an equal amount of oil, as the oil must be pushed out ahead of the acid. The oil has been in the rock perhaps millions of years and has thoroughly soaked and wetted the rock. The oil has a higher vis-

cosity than the acid.* The selection of a particular viscosity of acid cannot alter the force required to force the oil out.

Moreover, the acid is constantly eating the limestone and enlarging the channels so that flow through the portion of the rock in which it exists is practically unimpeded. The dam which must be broken down to permit the acid to flow into the rock is that formed by the oil and exists in the portion of the rock ahead of the acid. A very complicated condition arises at the places in the

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*The viscosity of crude oil varies considerably, depending on its gravity and other factors but the following values are of typical crude oils. In the following table, the viscosities of water, acid and brine are from the International Critical Tables — McGraw-Hill Book Company, 1929, pages 10 to 14. The viscosities of the oil are from Booklet No. 229, "Refining Characteristics of Illinois Crude," by Gustav Egloff, G. B. Zimmerman and J. C. Morrell, published by the Universal Oil Products Company, reprinted from "The Oil and Gas Journal," dated October 27, 1938. The figures given in this publication are in "Saybolt" units of viscosity, and have been converted to centipoises by employing the American Society of Testing Materials "Tables for Kinematic and Saybolt Universal Viscosities No. D446-39."

Viscosity of water at 25° C. — .894 centipoises
Viscosity of water at 40° C. — 0.653 centipoises
Viscosity of 15.4 HCl acid at 25° C.—1.157 centipoises
Viscosity of 28.6 HCl acid at 25° C.—1.529 centipoises
Viscosity of 19.8% CaCl brine at 40° C.—1.34 centipoises
Viscosity of 34% CaCl brine at 40° C.—3.36 centipoises
Viscosity of crude oil:
36.7 Gravity oil at 40° C — 4.02 centipoises
39.0 Gravity of oil 40° C. — 4.11 centipoises
41.3 Gravity oil at 40° C. — 4.32 centipoises

The Dow brief refers to a "viscous calcium chloride brine" (Dow brief, page 14). None of these liquids is properly called viscous. A viscous liquid such as glycerine has a viscosity 80 times that of water (Textbook of Physics by Duff, P. Blakiston's Sons, Philadelphia, 4th Edition, 1920, page 132).

channels, fissures or pores in the rock where the acid first comes in contact with the oil. At this "interface" the acid does not push all of the oil out of the fissures ahead of it. Some oil clings to the sides of the passages and until the acid has reacted with the limestone and enlarged these passages, the peculiar result is that the flow is impeded. The effect is the same as though the rock was actually less permeable. In other words, more pressure is required to force water through an oil soaked rock than is required to force an equal volume of oil, even though the oil has a higher viscosity than the water. This is brought out by Muskat, Page 478:

> "Effect of the Differences in Viscosity between the fluids on the Two Sides of the Interface . . . In truth, however, water and oil are by no means perfectly miscible and hence display a differential surface behavior which results in a retention by the sand of part of its original oil in spite of the flooding action of the encroaching water. The remnant oil will clearly lower the effective permeability of the flooded zone for the water which tends to pass through it . . . And although for analytical purposes this lowering of the original permeability due to the remnant oil may be immediately translated into an equivalent increase in viscosity of the encroaching water, it is important to note that this increase may be so large as to more than counterbalance the fact that the water is strictly of lower viscosity than the oil. In fact, it is quite possible that in actual encroachment systems the effective k/u for the flooded zone is *less* than that in the oil zone in spite of the lower real viscosity of the water."
>
> (Muskat, pp. 478-80.)

On page 14 of plaintiff's brief plaintiff speculates that 30% concentrated acid "enters the small rock pores more slowly and expends itself on the walls of the well hole and the rock closely adjacent thereto. The resulting spent acid solution is a viscous concentrated calcium chloride brine which must be forced out into the formation ahead of the incoming acid before fresh acid can enter and enlarge the pores." Plaintiff's speculations are contrary to the accepted belief of those who are skilled in this art.* If plaintiff's contentions are correct, acid of 5% concentration would work better than acid of 15% concentration, for the more dilute acid would enlarge the fissures and crevices even farther away from the well bore. Exactly the opposite is the case.

> "In some cases 5% or weaker acid has been used along with fast pumping rates in an attempt to delay the action on the lime and accomplish these same results. The fallacy in such reasoning lies in the fact that although 5% acid has a slower rate of reaction on lime than does 15% acid, obviously if 15% acid is put into a formation it will react for a considerable time while being forced away from the well before its strength is reduced to 5%. After this, it still will react for as long a time as would fresh 5% acid. Therefore, 15% acid will not be completely neutralized in as short a period of time as 5% acid even though the reaction rate is faster at the start of the injection."

Cf. F.F. 62, R. 1487:– "* * * A hydrochloric acid solution acts on limestone and is consumed to produce carbon dioxide gas and calcium chloride, which is very soluble in the solution, and hence, does not tend to stop the action of the acid by formation of a precipitate."

This last quotation is from an article entitled "Gas Well Acidizing in the Texas Panhandle," by Gilbert L. Leach, Dowell, Inc., presented at the Spring Meeting of the Mid-Continent District, A.P.I. Division of Production, Amarillo, Texas, March 21, 22, 1941. Dowell, Inc. is a wholly owned subsidiary of plaintiff, Dow Chemical Company.

The factor of primary importance is not the enlarging of the crevices, fissures or pores of the limestone far from the oil well, but on the contrary is the enlarging of the crevices or increasing the permeability of the rock at or near the bore hole or cavity of the well, since it is this portion of the formation which has to serve as the arteries or conduits which convey the oil into the well cavity.

> "As field experience has shown that the smaller producers usually react best to acid treatment, it must be concluded that in so far as the mechanism may correspond to the radial-flow case, the small producers are such because of serious plugging about the well bore rather than because of a low permeability in the main body of the limestone.
>
> "These results may be summarized as follows:
>
> "1. Small increases in the production capacity—up to about 50 per cent—due to acid treatment *may* be explained on the assumption that the permeability of a small radial zone about the well bore has been increased from normal to higher values, as well as by removal of radial plugging or widening of extended fractures fed laterally by the limestone proper. Unless the limestone does have extended fractures or is appreciably plugged near the well bore, acid treatment should be relatively ineffective in stimulating production.

"2. Moderate increases in the production capacity —50 to 500 per cent—can be explained on a radial-flow basis only on the assumption that the wells were initially plugged, the extent of the plugging being the principal factor in determining the initial production capacity, so that small producers will show larger responses. They can also be explained equally well by the assumption of the extended-fracture flow.

"3. Increases in the production capacity appreciably larger than 500 per cent, for wells of initially moderate capacity, can be explained only on the assumption that there are extended fractures in the limestone which are penetrated and widened by the acid. Here the smaller producers should show the greater responses, whether their initially small production capacities are due to low limestone permeabilities or small widths of the fractures. For very small producers, increases higher than 500 per cent could also be explained on the radial-flow mechanism of production, although it would have to be assumed that there was initially a condition of *almost complete plugging* near the well bore."

(Pages 427-428, Muskat.)

It therefore seems clear that acid of 30% concentration not only is more effective than acid of 15% concentration to react with the limestone nearer the well bore or cavity, but also better serves to enlarge fissures and crevices and increase the permeability away from the well bore, assuming that an equal volume is placed in the well. The amount of limestone dissolved in the fissures far away from the well bore depends upon how much acid is used, the amount of oil or water pumped in after the acid to force it into the rock, and the speed with which it is injected. The latter depends upon how much pressure is exerted by the pump or by the hydrostatic head of

fluid in the well. The dissolution of limestone far from the well cavity or bore also depends upon the concentration of the acid. The higher the concentration the more limestone is dissolved far from the well. This is stated in the article by Mr. Leach of Dowell, Inc. and presented by him as a fact to the meeting of the A.P.I. While acid of 30% concentration reacts with the rock immediately adjacent the bore hole or cavity, its acid content is not reduced to a strength of 15% until it has traveled some distance from the well bore and it is at that point that its rate of reaction with the limestone is the same as that which 15% acid would have at the point when the latter left the well bore. Acid of 30% concentration just naturally eats more limestone nearer the bore hole and it eats more limestone farther from the bore hole than does a weaker acid.

Introduction of the Acid Into the Well Through the Ordinary Pump Tube Already in the Well.

There was nothing inventive in this. In claims 8 and 9 of the Grebe & Sanford patent the use of the pump tube is included to set forth some utility for the inhibiting agent in the acid.

Long prior to the alleged invention of the patent in suit, the use of the ordinary oil well tubing to convey hydrochloric acid (either dilute or concentrated) into a well had been public knowledge. For example, the patent to Lake 1,498,045 [R. 1549], granted June 17, 1924, cited by the Patent Office Examiner [R. 2026] against the Grebe & Sanford application, recites:

"In accordance with the invention we introduce a suitable acid, such as commercial nitric acid, hydrochloric or sulphuric acid, . . . within the well hole, by passing it

through the rotary tubing. . . . If desired, the acids above enumerated, or other acids, may be diluted or in concentrated form, or for that matter introduced in solution within the well with the circulatory system of the rotary tubing, and thus be forced out of the hole around the tubing after it has acted upon the surface to be cleansed." [R. 1549, *ll.* 52-67].

In the patent in suit, the acid performs its function of dissolving the formation after it has been discharged from the well tube. The pump tube is used merely as a means for conducting the acid to the bottom of the well hole. It performs this conveying or conducting function in identically the same manner as the pipe A of the Frasch patent.

The record presents no evidence that Frasch conduit pipe A was ineffective or inoperative as asserted in Dow brief, p. 37. Any advantage existent in anything disclosed in the Grebe & Sanford patent respecting simplicity, cost, conduction of the acid down into the well, etc. (Dow brief, pp. 36-37) is to be found in the use of the inhibitor in the acid,—its reduction of corrosion of the metal equipment of the well. Inhibition of the acid reduces the corrosion of the tube but does not change its function or purpose, i. e., a pump tube in connection with a well with an oil pump to raise the oil to the surface; this has absolutely nothing to do with the use of the tube as a pipe conduit for conveying the acid to the bottom of the well. Each of these considerations emphasizes that the purpose of the claim is to point out, as required by R. S. U. S. Sec. 4888 (35 U.S.C.A., Sec. 33), the claimed invention, i. e., the use of an inhibiting agent in the acid to prevent attack of the acid upon metal

surfaces, e. g., of iron or steel, copper, etc., with which it comes in contact. [R. 1501, *ll.* 76 to 78.]

The Grebe & Sanford patent states that "It is not necessary, however, to add the acid solution through the pump tube, as any other convenient way may be employed. For instance, the pump tube may be withdrawn and a dump bailer used to lower a charge of acid into the base of the bore." [R. 1502, *ll.* 62-67.]

> "It is not invention to change a process, machine, manufacture or composition of matter, by substituting an equivalent for any of its parts; unless the new part, not only performs the function of the part for which it was substituted, but also performs another function, by another mode of operation."
>
> Deller's, *Walker on Patents*, Vol. 1, Page 209, Sec. 40, citing cases.

If as asserted in Dow's brief, p. 37, it be a fact that no suitable pump exists by which concentrated hydrochloric acid could be pumped, the alleged invention here in controversy is not the invention of such a pump.*

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*The statements in the Dow Brief such as that on page 38 that "no suitable pump then or now known could be used to pump concentrated acid", is without foundation. In the textbook entitled "Hydrochloric Acid and Salt Cake" by Cummings, Van Norstrand 1923, at page 383, it is stated:

> "Formerly, whenever it was proposed to lay out an alkali-works, the very first requirement to be fulfilled was to take care that no pumping of hydrochloric acid should take place on any account. * * *
>
> "Nowadays the position of matters is quite different. Even acid-resistant metallic alloys are known and employed * * *. The difficulty at present consists in deciding which of the many contrivances to choose for pumping hydrochloric acid, but nobody need now shrink from raising not merely weak but also strong acid to any desired height * * *".

Much emphasis is placed in plaintiff's brief upon the contention that the Grebe and Sanford method of using inhibited acid avoids the necessity of pulling the tubing out of the well and re-running it in preparing to acidize the well, as taught by Frasch. The record discloses that in some cases wells have been acidized without pulling the tubing. However, in the acidation of the Weber wells relied upon as infringements, the tubing was pulled and re-run [R. 302, 303].

The Use of a Packer.

Nor is there any foundation for plaintiff's assertion (p. 33): "Furthermore, the suggestion that the acid be prevented from rising to the height of the casing by means of a packer was not practical, as pointed out by the Court in the Tenth Circuit." Neither this contention nor this error of the Tenth Circuit Court has any basis in fact. On two of the three Weber Oil Company wells, packers were used by defendant [R. 287, 295, 304; R. 1811, 1816]. Plaintiff, like defendant, commonly uses packers for confining the acid to the particular formations to be treated [R. 210, 211]. Packers have long been used on tubing in oil wells. Both packers and their use were public knowledge in 1896. This Court in *Honolulu Oil Co. v. Halliburton*, 306 U. S. 550, points these facts out. This Court said: "A packer to separate one stratum of the oil well from another is old in the art" (p. 554). "Packers and pipes with valves in them have long been in use to get what is below the packer free from what is above and without removing what is above" (p. 555).

Forcing the Acid Into the Rock by Pump Pressure.

Plaintiff says that the "Grebe-Sanford process" was a commercial success because it involved pumping the acid into the rock whereas it asserts that Frasch did nothing more than enlarge the bore hole and Gypsy did not force acid into rock. Dow brief, pp. 4, 19, 28, 38, 39, 42, 44, 45, 51, 54, 55. The Grebe & Sanford patent does not describe or suggest that a pump be used *to force the acid into the rock*. The statement is "'force the charge of acid out of the pump tube." The patent states:

> "It is sufficient merely to pull the pump rod and valves, and to pour the acid solution into the well through the tube." [R. 1502, *ll.* 21-24.]
>
> * * * * * * * *
>
> "In order to force the charge of acid *out of the pump tube* into the *bore* of the well *against the head of oil standing in the hole*, it may be followed by a charge of oil, water or other liquid *sufficient to overcome the head*, or pressure may be applied by other suitable means, e. g., by air pressure or by means of a pump." [R. 1502, *ll.* 33-40.]

The patent does not point out any continuation of the pressure into the rock as material to the operation. It proceeds to say:

> "When introduced into the bottom of the well, the acid attacks the rock structure and dissolves or disintegrates it, thereby enlarging the pores and channels in the rock, or opening up new channels." [R. 1502, *ll.* 40-45.]

According to the patent, "The acid solution is preferably added in amount calculated to fill the bore of the well

to a depth not exceeding the thickness of the mineral bearing stratum." [R. 1502, *ll.* 29-32].

The Frasch patent statement [R. 1937, *ll.* 49-55] is much more specific in its directions:–

> "When as much acid as desired, say one thousand gallons, has gone into the rock, a force-pump is connected with the pipe A and fresh water is forced down to displace the acid in the pipe and rock, and by forcing it still farther into the rock extend the area of its action."

It was Frasch, not Grebe and Sanford, that used water "with the acid so that the acid may be carried long distances." [p. 1652.] It was Frasch who said that "a pump is used to press the acid back into the rock" [R. 1653] and who forced the rock to "take the acid and water" [R. 1653]. It was Frasch, not Grebe and Sanford, that wanted the water present to "bind the carbonic acid gas" generated in the channels of the rock by the reaction of the acid therein [R. 1652]. The only reference in the Grebe & Sanford patent to forcing the acid into the rock is "gas may be allowed to escape up the casing, or the latter may be capped off, thereby creating a gas pressure within the well which assists in forcing the acid into the pores and crevices of the rock." [R. 1502, *ll.* 48-52.]

Gas generated in the rock itself would not exert such pressure, and gas generated in the well could not force the acid very far. A pump is necessary. Not only does the Frasch patent prescribe the use of a force-pump for this purpose but the article in the Oil City Derrick [R. 1653] refers to its use.

There is no justification for the implication of plaintiff's brief that using pressure to force the acid and water into the formation was patentable invention on the part of Grebe and Sanford (Dow brief, p. 37, cf. (b) p. 14). On the contrary, the Frasch patent and this Oil City Derrick publication made this a part of the public knowledge and demonstrate that such public knowledge was not limited to a dependence "on the hydrostatic head of his (Frasch) acid in the supply-pipe to get the bulk of it into the rock," as asserted in Dow's brief p. 37.

The Gypsy Oil Company's Use.

Early in *1928* the Gypsy Oil Company had a problem in some of its wells in the Glenn Pool field in Oklahoma (a sandstone formation) caused by the formation of limestone scale or "gyp," as it is called, on the casing, tubing, working barrels, and pump rods and face of the sand in its wells; such formation interfered with the pumping of the wells and necessitated frequent shutdowns and loss of time in removing rods, valves, etc. and mechanically removing the scale [R. 1094]. The company sought a suitable solvent which would dissolve such scale while in the well and thereby avoid the frequent "pulling" jobs. It submitted its desires to the Mellon Institute at Pittsburgh [R. 1079, 1083], furnishing the Institute with specimens of the scale for analysis and determination of its characteristics and chemistry. A report by Dr. Wescott on behalf of the Institute was made respecting this "Scale Formation in Wells." [R. 1908-21; *Cf.* F. F. 66–

R. 1487-8]. "The purposes of the investigation were to determine the cause of the deposition, to find a method for its removal and to ascertain whether the formation of the scale could be prevented. The first two objectives have been accomplished; the third is still a matter for study at the present time." [R. 1908]. This report discloses an application of public knowledge by chemists (1) that hydrochloric acid was a solvent for limestone, and (2) that the corrosive effect of such acid could be minimized ("inhibited," as this term is used in the Grebe & Sanford patent) by the addition to the acid of the commercially available Rodines. Under the heading, "Removal of the Scale.", the report states:—

> "Since the scale was shown to consist mainly of calcium and magnesium carbonates, the selection of a solvent was a simple matter. The scale was easily soluble in all mineral acids but the most suitable one was hydrochloric acid because the products of the reaction of the scale and hydrochloric acid are all soluble and offer no difficulty of removal. The use of an acid in removing the scale involves the loss of some of the metal of the tubing, casing and sucker rods by solution in the acid. The casing in the Glenn Pool field is old and probably more or less severely corroded in spots. The corrosion in areas subjected to scale deposition is probably slight as the scale forms a very efficient protective coating. There are available on the market, numerous patented materials called inhibitors which are used principally in the commercial pickling of iron and steel products to reduce the loss of metal by solution in the acid. Some of these materials are very efficient in their action in dilute acids. Among

the most successful of the inhibitors are a series of materials called Rodines, manufactured by the American Chemical Paint Company of Ambler, Pa."* [R. 1913-14].

"* * * There is no doubt that for the purpose at hand that Rodine No. 2 will prove most suitable. It not only affords greater protection but is much easier to handle since it is a liquid.

"The results given in Table 5 indicate that perfect protection to the steel could most probably be insured by the use of sufficient Rodine. It would not be economical to do that however. * * *" [R. 1915].

Under the heading, "Theory of Inhibitors," it is stated:—

"The commercial use of inhibitors for the protection of metals in acid solutions is not new. A very great number of substances have been studied for their inhibitive value; some have been good, others worthless. There has been no definite relation indicated between chemical properties and inhibitory value. The mechanism of the inhibitive action is very little understood. Some inhibitors are colloidal in nature and it has been noticed that the over-voltages at anode and cathode in acid is increased proportionally to the colloid concentration. Some substances, such as formaldehyde and quinoline ethiodide exert powerful inhibitory action when only very small amounts are present, suggesting that the effect is

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*"Prior to Letters Patent 1,877,504, it was well known that numerous agents, including the preferred agent (arsenic compounds) mentioned in Letters Patent 1,877,504, could be added as inhibitors to hydrochloric acid to reduce the corrosive action of the acid upon metals such as steel." [F.F. 73 – R. 1489; *Cf.* F.F. 75, 76.]

catalytic in nature. It has also been suggested that the inhibitor forms some sort of film over the cathode which acts to prevent the ready evolution of hydrogen. The most recent explanation advanced for the action is as follows:

"Iron immersed in acid goes into solution at the anode areas, forming iron ions in solution and depositing an equivalent amount of hydrogen ions at the cathodic areas. These cathodic areas are assumed to occur principally in the grain boundaries of the crystals in steel or at the interface of slag and iron in wrought iron. Most inhibitors are either organic bases or positively charged colloids, and when these are present, they travel to the cathode areas with the hydrogen. When the positively charged heavy particles of the inhibitor are discharged at the cathodes, they cannot escape by gaseous evolution, and accordingly are absorbed on the surface building up a protective layer." [R. 1916].

The report recommends "that the removal of the scale by use of hydrochloric acid and 4% of Rodine No. 2 or other inhibitor of equal effectiveness be tried in one well of the Glenn Pool." [R. 1921]. Among the conclusions stated in the report were: "The only economically available solvent for the scale is hydrochloric (muriatic) acid." "Hydrochloric acid treated with a sufficient amount of a suitable inhibitor may be used without fear of damage to sucker rods, tubing, casing or other ferrous materials in the well." "Rodine No. 2 (or other Rodines having like inhibitive value) used in the proportion of 3% to 5% by volume of acid affords ample protection to the ferrous materials in the wells." [R. 1920-21].

With respect to Gypsy Co.'s operations, Dr. Knappen testified: "The purpose of giving that well (Berryhill No. 8) treatment was both to increase the production from the well and also to reduce the amount of operating trouble in the well. If we could remove the scale from the face of the sand we could increase the production. * * *." [R. 1085].

This purpose is not something that occurred to Dr. Knappen after the Grebe-Sanford patent issued. The Wescott report of June, 1928, stated: "The release of pressure probably occurs at the surface of the sand in the well cavity, in which case it is reasonable to suppose deposition of more or less of the *scale on the surface of the sand*. Therefore, the trial would be well worth the expense for its possible value *in increasing the production* of the well *entirely aside* from the object of removing the scale from the pipe." [R. 1921].

While the Wescott report suggests the commercial acid (30% HCl, 70% water) be placed in the well, it was not the intention that the acid remain undiluted in the well. The wells were producing water with the oil [R. 1073, 1911]. The report states that Table 5 indicates that *perfect* protection of the steel could most probably be insured by the use of sufficient Rodine; that it would not be economical to do that; and that the corrosion reduction results indicated in the table "are considerably higher than those that would actually be met with in practice because of the dilution of the acid by fluid material in the wells" [R. 1915]. Wright, the field engineer who mixed the Rodine with the acid, testifies that it was "dilute hydrochloric acid" [R. 1066].

On *November 12, 1928*, the Gypsy Oil Company's Berryhill No. 8 well in the Glenn Pool was treated with hydrochloric acid containing Rodine No. 2 purchased from American Chemical Paint Company [R. 1078, 1094]. This treatment "was a complete success from the standpoint of well trouble, and there was no subsequent gypped tubing in this well for many months." [R 1096]. Similar treatments of other wells followed [R. 1102, 1109] "Use of the inhibited hydrochloric acid in the wells of the Glenpool by the Gypsy Oil Company was scientifically successful, but economically unsuccessful, because the acid was costing us forty cents a gallon and we were dealing with small wells at a time when the price of oil was very low. It saved money in the operation of the wells over what it cost to operate them without using the acid. I believe there was some increase in production by use of this acid rather than our old cleaning-out method, but I cannot put my finger on precise figures because the wells were pumped into a lease tank battery so that many wells were produced into the same tank." [R. 1080]. "There were economic or other reasons why the Gypsy Oil Company did not in the year 1928 and '29 further pursue the method of attempting to increase their production with the use of inhibited hydrochloric acid. The cost of acid was approximately forty cents a gallon, making the cost of treatment of any of those wells very high. At that time we had more than two million barrels of Glenpool oil in storage. We foresaw a decrease in the market price and had no desire to increase our reserves and accordingly decided to delay further acidizing operations until we had either a shortage of that grade of oil or a more favorable market." [R. 1089] "Our question was whether it was saving us

enough money to justify the work." [R. 1009] *Cf.* F. F. 66, 67, 74 [R. 1487-9].

Plaintiff argues that production on Berryhill No. 8 was not increased by the acid treatment. The record does not conclusively establish whether or not there was an increase [*Cf.* R. 1080, 1085]. It is not material here whether the oil production was increased (*Smith v. Hall*, 301 U. S. 216 at p. 232) [*Cf. comments, District Court* – R. 1435-7]. Whether or not an increase in production resulted, inhibited acid admittedly was used by Gypsy Co. and its use was successful* [R. 1456; *Cf.* R. 1096].

There is no difference between this use and the use contemplated by the patent in suit. The Grebe & Sanford patent [R. 1501] states the object of the alleged invention "is to counteract some preventable natural causes for the decline of yield of a well," [*ll.* 8-11] caused by "the building up of solid deposits of wax or the like in the channels and pores of the oil-bearing rock which obstruct and finally may cut off altogether the flow of oil to the well." [*ll.* 24-28.]

Plaintiff advertises [Exs. 242, 243; R. 1790, 1791] its "Lime Scale Removal" Process, and initially included such treatments in its exhibit [Ex. 94, R. 1655] showing commercial success of the patent in suit [R. 166, 845]. There is no essential difference in the action of hydrochloric acid after it is in the well whether the formation is limestone or sandstone. If there is any lime in the sandstone formation, the reaction would be the same [R. 37].

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*The problem of preventing the formation of gyp by the use of acid has nothing to do with Dr. Wescott's recommendations [R. 1121]. This problem does not pertain to the Grebe-Sanford patent.

Plaintiff based its suit against Williams Bros. on the treatment of a sandstone by that concern. [See record of Williams Bros. case, Phys. Ex. 297, p. 31.]

Plaintiff now seems to admit that the acid used in the Wm. Berryhill No. 8 well reacted with the soluble binder in the sand (Brief, pp. 51, 54). Unless this binder were dissolved, the well could not have filled with sand as alleged.

While a single public use invalidates a patent, *Electric Storage Battery Co. v. Shimadzu*, 307 U. S. 5, 20, the record contains proof of treatments of other wells which followed the Berryhill No. 8 well [R. 1075, 1079, 1101]. Besides the testimony of Dr. Westcott* [R. 1110], the record contains the testimony of the engineering assistant to the vice-president who supervised what was done [Dr. Knappen – R. 1077]; of a graduate petroleum engineer [Wright – R. 1065] who mixed the acid and inhibitor and was in charge of the work in the field; and of one of the men who did the work [Kiser – R. 1075]. This evidence clearly establishes that Berryhill No. 8 well was treated with acid three times; on Nov. 12, 1928 [R. 1922]; Nov. 7, 1930, and Mar. 10, 1931 [R. 1075]. Four other Berryhill wells were treated: #9, July 29, 1929 [R. 1075-6]; #11, Sept. 11, 1929; #26, Aug. 5, 1929; #1, July 25, 1930 [R. 1076]; also three other wells: Vowell

*Dr. Wescott did not testify in the *Williams Bros.* case. In this case he testified [R. 1110-1129] that the conclusions of the Tenth Circuit Court of Appeals as to the work he recommended were not correct, particularly respecting whether experimentation was necessary to determine whether inhibited hydrochloric acid would react with the calcareous deposits in a well [R. 1116-1119]; and whether the results obtained were contrary to the forecasts made in his report [R. 1117, 1120-1121].

#3, Sept. 30, 1929; Gilcrease #22, Sept. 4, 1929, and Rhodes #6, Sept. 20, 1929 [R. 1076]. The records produced specifically show that inhibitor was used with the acid in the treatments, on Berryhill No. 8, Nov. 12, 1928 [R. 1922], and #11, Sept. 11, 1929 [R. 1076, 1077, 1101], and Gilcrease #22, Sept. 4, 1929 [R. 1076, 1077, 1101]. It is these three treatments that are specifically mentioned in the District Court's finding of fact No. 67 [R. 1488]: "That work for the Gypsy Oil Co. was under my supervision. I have the reports and can produce them." [Knappen – R. 1088].

The treatment of these wells by the Gypsy Oil Co. was not an "experiment" in the sense that this word is used in patent law. *Smith & Griggs Mfg. Co. v. Sprague*, 123 U. S. 249, 31 L. Ed. 141. "We had a profit motive for treating these wells" [Knappen – R. 1097]. This use of inhibited acid by Gypsy was not abandoned. "The Gypsy Oil Co. since June 30, 1930 surely has continued to use inhibited hydrochloric acid in oil wells down to the present date. To my knowledge they have never been sued by the Dow Chemical Co. for alleged infringement." [Knappen – R. 1081, *Cf.* 1097].

While the Gypsy Oil Co. called Dow Chemical Co. to treat some of its wells in 1933, it also called the Chemical Process Co. [R. 1089] and also treated many of its wells with its own equipment without calling any oil field service company [R. 1088].

The reason it called Dow Chemical Co. to treat a well in 1933 was because it had no acid truck available in the field where it wanted to treat the well, whereas the Dow Chemical Co. did have a truck there. "the well was located up in Kansas, remote from the place where we

expected to do most of our work and it was cheaper to employ them (Dow) to treat the well than it was to move our truck and our acid from Seminole (Okla.)" [Knappen – R. 1089].

"The Use of This Very Process Was Suggested to Grebe and Sanford by the Pure Oil Company Prior to the Issuance of the Patent in Suit and Was Not Original With Them."

(Opinion, Court of Appeals, Sixth Circuit [R. 2059].)*

Plaintiff first became interested in the use of hydrochloric acid to dissolve limestone formation in an oil well to increase its production through an inquiry on behalf of the Pure Oil Company. Wm. A. Thomas was employed by the Pure Oil Company as a geologist. "In December of 1931 I had an idea that acid could be used on lime wells in the Greendale pool. I went over to Dr. Grebe, who was in charge of the research at Dow Chemical, and I might say I was introduced to Dr. Grebe by Ross Sanford." [R. 1010]. He went to plaintiff "to get the price on hydrochloric acid." [R. 1011]. He asked Dr. Grebe how much limestone that hydrochloric acid would dissolve. An assistant of Dr. Grebe's gave him the figures [DX 300; R. 1993]. Whether it was Thomas, Dr. Grebe or this assistant who suggested 20% hydrochloric acid is not clear from the record. It is clear that the figures given to Mr. Thomas were based upon 20%

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*"The acidizing of oil wells with hydrochloric acid to increase the production of the wells was suggested to the applicants for Letters Patent 1,877,504 by representatives of the Pure Oil Company and was not original with or conceived by such applicants." [F.F. 72 – R. 1489.]

acid.* That plaintiff recognized there was substance to the claim of the Pure Oil Company that it suggested to plaintiff the use of hydrochloric acid to increase oil well production, is definitely proven by the fact that under date of January 31, 1933, plaintiff entered into a written agreement with Pure Oil Company in which plaintiff provided that it "shall grant unto Pure without royalty charge a non-exclusive license under Patent 1,877,504, and under any other patents which Dow may acquire, own or control relating to acid treatment of oil or gas wells," [R. 1874]. This was limited by a subsequent agreement "to the treatment by Pure of its own wells within Michigan." [R. 1878]. This first agreement was entered into after a dispute arose between plaintiff and Pure Oil Company regarding the parts that plaintiff and Grebe and Sanford had in the use of hydrochloric acid by Pure Oil Company in acidizing its wells [*Cf.* DX 301; R. 1994; DX 302, R. 1998; DX 303, R. 2000].

In February, 1932 an oil-well was treated by Pure Oil Company with hydrochloric acid furnished by Dow Chemical Company. The treatment caused an increase in production and, as a result, several more wells were acidized by Pure Oil Company in the spring of 1932, the acid being furnished by Dow Chemical Company [R. 1018-19].

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*"The Court: * * * I take it that you do not dispute that this witness right here (W. A. Thomas) for the Pure Oil Company, went there to get the well treated—is that right? Do you dispute that? That they took the initiative in that regard? Is that disputed at all?

"Mr. Owen: No." [R. 1021]. [*Cf.* F.F. 72, R. 1489].

The record does not show that an inhibitor was added to the hydrochloric acid in the treatments of either the first or second wells by Pure Oil Co. Thomas did not order any inhibitor [R. 1021] and as far as he knows none was used on the first few wells [R. 1015]. The acid was hauled to the well in a wooden tank [R. 123]. The Dow Chemical Co. records do not show that any inhibitor was ordered for Pure Oil Co. in February or March, 1932 [R. 114-16, 136-43] or that any inhibitor was paid for by Pure Oil Co. during these months [R. 141-2]. The written orders from the sales department of Dow Chemical Co. to the acid department of Dow Chemical Co., calling for the delivery of hydrochloric acid to Pure Oil Co. during these months, do not include any arsenic acid [R. 113, *et seq.*]. These orders are PX 231-A—231-J [R. 1777-86]. The first of these orders which mentions arsenic acid is PX 231-C [R. 1779] dated April 4, 1932.

On *April 28, 1932*, Pure Oil Co., through Richard H. Carr as inventor, filed application for a patent upon a method for facilitating the flow of wells by the use of hydrochloric acid to dissolve limestone formations. This application was later rejected as anticipated by the Frasch patent 556,669. This application was abandoned after Carr on *June 30, 1932* filed the application for patent 1,891,667 [R. 1989], which states that: "This invention is a continuation-in-part of the disclosures set forth in my prior application, Serial No. 608,147, filed April 28, 1932." [*ll.* 17-19].

On *June 9, 1932* [PX 14 – R. 1626] plaintiff caused to be published in "The Midland Republican" of Midland, Michigan an announcement and advertisement:

"TREAT WELLS BY DOW PROCESS
TO JUMP PRODUCTION

"New Acid Injection Said to Have Increased Stripper Flow as Much as 10 Times

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"Contracting Work in Midland Field

"A new process of injecting acid into oil wells, which is supposed to increase the porosity of the oil bearing sand and result in a heavier flow of oil from wells which have nearly stopped producing, was announced this week by Dow officials. Oil men are showing a keen interest in the process, which they believe would revive old wells, especially since it has been said to produce as much as ten times the original flow in one stripper. The process in no way affects the quality of the oil.

"The idea is an outgrowth of a process developed for increasing the flow of brine wells. Dow Chemical Co. is contracting to treat wells, but does not take any responsibility for results accomplished. The services of an engineer are to be made available for the new work. Robert Quinlan has been placed in active charge of the work through the sales department. *The acid used is trademarked Dowell and the process covered by application for patents.*

"Since the commercial use of the acid was decided upon the GLeeP firm has been the first to contract for its use. According to Laurence W. Lee, an of-

ficial, one well is being treated while six more are to be given acid in an attempt to bolster production.

"The treatment has been used on a number of wells in the Midland-Isabella field and found satisfactory according to those in active charge.

"Enthusiastic reception by oil men, lease holders and land owners has been given wherever the process and its working have become known. In it, they see possibilities for getting many times the present production from wells, which have practically ceased to be of any value. This may mean the reworking of dozens of sites in the field and stir a new line of activity."

No mention is made in this inspired article that the "new process of injecting acid" included or depended upon the use of any inhibiting material in the acid. The article does not even identify what acid is used. It states, "The acid used is trademarked Dowell *and the process covered by applications for patents.*" However, the application for the Grebe & Sanford patent was not filed until June 30, 1932, three weeks *after* the publication of this article. *Two days prior* to this publication, a draft of an application for patent by John J. Grebe had been prepared [DX 304 – R. 2002-09]. One significant fact disclosed by this draft is that at the time of its preparation plaintiff had no knowledge of the Frasch patent. A second significant fact is that one of the proposed claims was: "1. In a method of increasing the output of a well for producing a fluid mineral product such as oil, gas, water or brine, the step which consists in introducing a mineral acid solution into the mineral bearing rock strata adjacent to the bore of the well." [R. 2007]; that proposed claim 8 [R. 2008]

defines the mineral acid as "a hydrocloric acid solution". This method is particularly described in the paragraph commencing at bot. R. p. 2003.* At this time plaintiff believed this Pure Oil Co. operation was the first use of hydrochloric acid to dissolve limestone to increase the production of an oil well. The reduction of corrosion of the metal parts or surfaces of the oil well equipment presented no problem whatsoever to Grebe and Sanford. It was obvious to them from their familiarity with "the known inhibitors which are used for acid pickling baths and the like" [R. 2005]. This draft does not indicate that plaintiff then thought such method was inoperative "due to the fact that the acid attacks the metallic casing, pump tube, etc. about as actively as the rock, and causes serious damage thereto." [patent in suit – R. 1501, *ll.* 54-7]. This statement was first made in the revised Grebe & Sanford application, prepared subsequent to a search of the Patent Office records which disclosed the Frasch patent. In this original Grebe application draft, the corrosive action of the hydrochloric acid was acknowledged to be a mere incident which could be minimized by the selection and use of "any of the known inhibitors which are used for acid pickling baths and the like" [R. 2005]. This exhibit DX 304 contains the notation, "Copy of this draft sent to Nelson**

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*See District Court's remarks [R. 1437] when considering proposed Findings of Fact.

**Evidently the Almon S. Nelson who made the affidavit [R. 2023-4] in support of the petition [R. 2020-21] that the Grebe & Sanford application S. No. 620,292 "be advanced for special action"; in such affidavit Nelson "avers that he has made a complete and comprehensive investigation through the appropriate classes of patents in the United States Patent Office * * *" and "has failed to find any patent or patents * * *"

at Wash. for use in connection with search. E.C.B." [R. 2002]. The record does not disclose the report upon the search made to ascertain the novelty of the claimed invention. A revised limited application, in the name of John J. Grebe and Ross T. Sanford, was prepared [R. 2012-18] and signed June 24, 1932. This application acknowledges the Frasch patent 556,669 [R. 2013; patent in suit—R. 1501, *l.* 44]. Plaintiff offered no evidence in explanation of the limitations imposed upon the revised application. No acknowledgment of the Gravell patent 1,678,775 is contained in the revised application. Omission thereof may have been intentional, or the Gravell patent may not have been discovered by Nelson. This fact increases in importance when it is noted that this Gravell patent 1,678,775 was overlooked by the Patent Office in considering the application for the Grebe & Sanford patent.

Oil Makers Company.

In *June, 1932,* Charles I. Dougherty, Fred Markey, Edgar Lee, and Walter Sprenger, at Mt. Pleasant, Michigan, formed a company to go into the business of acidizing oil wells for others [R. 1195]. In October, 1932 they organized as the "Oil Makers Company" [R. 1256]. Dougherty, Lee and Sprenger were called by plaintiff to testify. This group began acidizing wells in June, 1932 and continued in business for about one year [R. 1195]. Until September of 1932 they used raw commercial hydochloric acid purchased from Penn Salt Company [R. 1166, 1193, 1196, 1197, 1199]. In September, 1932 they purchased *some* acid from Grasselli Chemical Co. containing "Duclean No. 2", a pickling compound [R. 1174-6, 1178-80, 1193, 1199-1201, 1236]. Plaintiff from 1934 to 1936 or 1937 used a pickling compound called "Murodine" pur-

chased from Mr. Gravell's American Chemical Paint Co. [R. 131].

With both Penn Salt Co. uninhibited acid, and Grasselli inhibited acid, the Oil Makers experienced some trouble due to corrosion [R. 1218, 1220, 1226, 1230]. Dougherty testified: "The trouble was that we left the acid in the well too long, or something." [R. 1222]. At that time, the poor equipment available, and lack of knowledge as to how to proceed, caused trouble for everyone in the business, including plaintiff [R. 1222]. Yet the record shows that these people treated many wells successfully with uninhibited hydrochloric acid, and without material damage to the metal in the well. Thirty-five or forty wells were treated by the partnership with Pennsylvania Salt Co. commercial hydrochloric acid [R. 1225-6].

> "From a standpoint of increased production to these wells, we had just about as much success and just as good results when we used the acid from the Pennsylvania Salt Manufacturing Company as we did when using the acid from the Grasselli Chemical Company." [R. 1226; *Cf.* R. 1220-21, 1229, 1231, 1261, 1265-8, 1280-81, 1292, 1299]

> "* * * Page 1 of this book, carrying the account of the McClanahan Oil & Gas Company, shows that according to this book we made fifteen treatments for that company. Practically all of these treatments were successful. I don't recall of any complaints of any kind that we have had from this company. The big majority of these fifteen treatments made by the Oil Makers Company for the McClanahan Oil & Gas Company were made with raw acid.

"The next account is that of the Stork Oil Company, for whom the Oil Makers treated three or four wells. I think that all of these acid treatments were successful. I think we made three treatments for them and gave them one free treatment. It would seem that we were using Grasselli acid in treating these wells for the Stork Oil Company." [Dougherty – R. 1220.]

The customers were in general satisfied, as shown by the testimony of Crampton, a superintendent for one of the customers, called by plaintiff to testify [R. 1290-94]. "We were pleased with the results of the first treatments in July and August, 1932, and thought that they were worth while." [R. 1293]. Plaintiff's witness Sprenger, testified [R. 1281]:– "Mr. Lyon:—And you had recovered maybe 30,000 barrels of oil because of this acid treatment, I think you admitted this morning, didn't you, that they would have been glad to have bought several working barrels, if necessary, in order to get the results of that acid treatment? A.—They were a pretty happy bunch." Sprenger's testimony contains page after page of testimony from records he made at the time of the treatments, where damage was done only occasionally [R. 1261-72]. The District Court's conclusions, after carefully considering Sprenger's testimony, were:–

"The Court: I think while this is right here before me, and I don't close my mind to these things until I decide a lawsuit, but I think I will say on the record that my present impression is that these records are genuine. I don't think they have been made up. I may have asked some questions, I always do, to try and find out things, but I think the records are genuine, in other words, that he made them at or about the time he was treating the wells.

"Evidently what he had in mind was whether this acid was going to eat the rock or not and the success of making greater producers. He certainly didn't start out with the idea of how much damage was going to be done to tools, and in spite of the fact he doesn't accept my offered explanation, I am inclined to think it would be a little later that he found out about any damage, that if he did find out was done, and therefore that is to my mind a satisfactory explanation as to why there isn't anything at all about damage in these records he has got.

"I think I should add right on there, however, that there no being a word about damage to any of these wells, he depends entirely on his memory, and we can see as to some of these things, for instance, as to when he began to keep records, and some things, he is quite faulty as to his summary, and this does depend entirely as to the damage and amount of this damage on his memory, and isn't helped in any respect by the record he has made." [1288-9.]

On some of the wells the pipe was old, and it is not possible from testimony to determine whether its condition after acidizing was due to corrosion by the acid or due to rust [R. 1169]. One of the complaints was based on alleged corrosion on the *outside* of the pipe, although the acid had been pumped *through* the pipe [R. 1185].

It is not possible to determine how many of the complaints about damage to the wells were due to competitive activities of plaintiff. From the start, when Dougherty and his associates were using no inhibitor, plaintiff threatened them and their customers. Edgar Lee testified:—

"The Court: You don't know whether some of these fellows that were selling inhibited acid were

there talking to him and telling him what a dangerous thing he was doing to use acid without an inhibitor?

"A. I presume some of the people were, yes, but that I couldn't say.

* * * * * * * *

"Q. And all those fellows selling inhibited acid were claiming that if you did not have inhibited acid, you would get your pipes eaten up?

"A. I presume they were, yes." [R. 1169; *Cf.* R. 1172-4].

Dougherty testified:—

"The Court: Now, I call your attention to the fact that the Dow patent did not issue until September 13, 1932, and if you are right as to his saying they had the patent I was wondering if it was not later than that, or whether he said they had a patent or going to have. I just call your attention to that, because I can see you are trying to tell me the way it was and all that.

"A. We heard that right from the start, that Dow had applied for a patent or had one, and was going to stop us from using this acid to treat wells.

"The Court: Acid to treat wells?

"A. Yes.

"The Court: Even raw acid?

"A. Well, yes, even raw acid at that time, because there was an appliance of putting it in under pressure and they had that patented, and all that." [R. 1216.]

Before the partnership had actually used any Grasselli inhibited acid [R. 1172-4, 1177-8, 1181, 1238, 1215-16], plaintiff under date of September 23, 1932, notified Oil

Makers that they were infringing the Grebe & Sanford patent 1,877,504. The letter [R. 1172] states: 'You are respectfully requested to immediately discontinue *the use of acid in any manner* which will infringe the rights secured to us by the aforesaid patent." [*Cf.* Dougherty's testimony on redirect – R. 1252-3]. The personnel of Oil Makers understood the notice to mean they had to stop acidizing wells, whether inhibitor was used or not [R. 1173].

The Oil Makers had to go out of business because they did not have sufficient capital and because they and their customers were afraid of suit by The Dow Chemical Company:–

> "* * * The reason that our company was unsuccessful and had to go out of business was that the price of oil went down in Texas and Louisiana. It was just impossible to make collections. No one wanted to treat their wells to increase production when they weren't getting enough money for their oil.
>
> "Mr. Lyon: Well, if you had had the resources even mildly comparable to the Dow Company to carry through that kind of a situation is there any reason that you know of why you couldn't have gone ahead with the business and made a success of it?
>
> "A. Well, yes, there is one reason why we couldn't. We weren't large enough and there were a lot of the small operators *that wouldn't allow us to put acid in their wells because they were afraid of the suit against them by The Dow Chemical Company.*

"Q. Afraid of being sued—

"A. (Witness interposing) —by The Dow Chemical Company, yes. *They wrote letters to every producer in this field, every company we would treat a well for they would get a letter from The Dow Chemical Company, they were liable to suit with us for infringement.*" [R. 1238.]

Plaintiff attempted, by the testimony of these witnesses, to show that the business of Dougherty and his associates was abandoned because of the corrosion of the casing, tubing, etc. in the wells acidized without inhibitor, but this attempt was wholly unsuccessful.* Milfred Wells testified to the payment to the partnership of $175.00 for acid treatment on Oct. 24, 1932 [R. 1300]. The well was Hastings No. 1, Greendale Pool, Michigan. Production was increased threefold [R. 1299]. The partnership treated 15 wells for McClanahan Oil & Gas Co., at least the first nine being treated with raw commercial hydrochloric acid: "Practically all of these treatments were successful." [Dougherty – R. 1220]. "While we were in this business of treating wells with acid, we treated for practically all of the oil companies in Michigan," [*Id.* R. 1199]. The testimony of Crampton [R. 1292] details the treatment of some fourteen wells, all of which were successful, without any damage or injury to the well equipment or pipe. Crampton testified: "I have experienced damage to three wells as a result of treating them with acid and have had acidized, all told about 400 wells."

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*F F. 78, R. 1490:– "The rate of corrosion of raw commercial hydrochloric acid upon steel does not result in any material damage to the well pipe or equipment in the well during a great majority of the usual commercial acidizing operations."

[R. 1294]. A complete reading of the testimony of Edgar Lee [R. 1166-94], Dougherty [R. 1195-1256], and Sprenger [R. 1256-89] discloses the extreme care with which the District Court considered plaintiff's effort to discredit the success of the partnership's treatment of wells with commercial hydrochloric acid. The District Court heard these witnesses, observed their demeanor on the witness stand, and had the advantage of their testimony in full as given. This testimony fully supports the District Court's Findings of Fact 78, 79, 80 [R. 1490].

In the *summer of 1932*, the Oil Makers partnership acidized a well for Pitzer and West at Breckenridge, Texas. Commercial hydrochloric acid without inhibitor was used [R. 1213, 1003]. "Our treatments consisted in just putting the acid into the oil well and displacing it either with water or oil to push it back into the formation. The acid was forced into the formation using whatever method was necessary, either from vacuum or from pressure." [R. 1003]. Pitzer incorporated [Oct. 12, 1932 – R. 1006] "The Chemical Process Company," which engaged in the business of acidizing oil wells. "Prior to the organization of that company I and my associates acidized some few oil wells, less than ten, I would say. Some of these wells were my own, the remainder belonged to others. These wells were located in Stephens County, Texas. * * * We used muriatic acid in treating this well. * * * There was no inhibitor or other chemical used in treating this well. We used just straight acid." [R. 1003]. "Since the organization of The Chemical Process Co. to date that company has made approximately fifteen thousand treatments to oil wells. This work has been done for practically the entire oil business." [R.

1003]. "In these thousands of treatments we have made, we have used an inhibitor on a few wells. We did not use any inhibitor in 1932 or in 1933. We used the last inhibitor on a few wells during the period between the time of the decision in *The Dow Chemical Company v. Williams Brothers Well Treating Corporation* suit, between the time it was tried and reversed. It was between the time of the trial of that case and the time the Appellate Court in Denver reversed it. We only used an inhibitor on a few wells between that time and the time it was reversed. It was not our common practice. After the reversal of that case we never used any more inhibitor and we have not used any since that time." [R. 1004]. "Out of the numerous wells we have treated with acid for the various oil companies, I think we have received one or two complaints due to the corrosion of the iron in wells. I do not regard the use of an inhibitor as necessary to the successful treatment of an oil well" [R. 1005]. "The acid treatment materially increased the production in this field, and in this district in 1932, I would say, we had anywhere from a two-barrel increase to a hundred-barrel increase per day for each well. I think some of the increases ran even higher than that, but that is just a picture of it." [R. 1005]. "Mr. West, my associate, and I learned of the acidizing business in 1932 from a couple of fellows, named Markham and Melville, who came here and wanted to make an experiment with acid. I never heard of Dowell Incorporated or The Dow Chemical Company having acidized wells prior to the time we started acidizing wells." [R. 1006]. Mr. Pitzer produced a complete mimeograph copy of record of the wells treated during the first year. It was introduced in evidence as DX 298, but is not re-

produced in the record herein [*Cf* Pitzer's re-direct examination R. 1007-09]. On January 3, 1934 plaintiff sued The Chemical Process Company in the Eastern District of Oklahoma for infringement of the Grebe & Sanford patent. Upon Chemical Process Company filing an answer denying validity and denying infringement, and filing answers to interrogatories in which it stated that it had not used any inhibiting agent or compound, the suit was dismissed without prejudice on May 8, 1934. Certified copy of the record in this suit is (physical) Exhibit 16.

No further suit was ever filed by plaintiff against Chemical Process Co. for infringement of the Grebe & Sanford patent. In several places plaintiff (Brief, pp. 27, 49, 50) asserts that the use at any time of uninhibited acid by the Chemical Process Co. is not established. The District Court found [F. F. 79, R. 1490] that many wells had been acidized with uninhibited acid. This finding is supported by ample evidence and is not based on Pitzer's testimony alone. The customers of Chemical Process Co. understood the acid was not inhibited.* Plaintiff hired a detective to investigate the activities of Chemical Process Co. He found that it was using a rubber-lined tank in which to haul the acid [R. 1319]. In 1939 this detective obtained samples of Chemical Process Co.'s acid from that tank and turned them over to plaintiff's counsel [R. 1319]. Obviously the rubber-lined tank was used because of the corrosiveness of the acid. It was not inhibited

*"I know that the Chemical Process Co. has treated a number of wells for Gypsy or Gulf under my direction and it is my understanding that inhibited acid has not been used by the Chemical Process Co. since the date suit was filed by the Dow Chemical Co. against the Williams Bros. Well Treating Corporation." Dr. Knappen – R. 1092.

against such corrosion. Plaintiff's counsel possessed this information before the trial. Had Chemical Process Co. used inhibited acid it would have been easy of proof by plaintiff.

The Williams Brothers Decision. – Its Erroneous Assumption of Facts, and a Comparison Thereof With the Facts Established by the Record Herein.

The *Williams Brothers* decision is predicated upon an assumption that: "Frasch's method was cumbersome and expensive, and probably impractical because of the inherent difficulty in adequately sealing off the acid at the bottom of the hole. *In any event Frasch's patent met with no commercial success.*" (81 F. 2d 496). No proof was before the Court in that case of any use or attempted use of the Frasch method. Here, the Court heard oral testimony and considered documentary evidence establishing the successful commercial use of such process (*Cf. supra*, pp. 20-24) and found that:– "The method of acidizing disclosed in the prior patent to Frasch, 556,669 granted March 17, 1896, was successfully used on a commercial basis in the acidizing of a number of wells near Lima, Ohio in 1895." [F. F. 71 – R. 1488-9]. The *method of acidizing* disclosed by the Frasch patent was the forcing of raw hydrochloric acid under pressure into the limestone formation to dissolve the limestone (as analyzed, *supra*, pp. 24-26). The specific *method of protecting* the casing, pump tubing, etc.,—the metal surfaces,—from the corrosive action of the acid, described in detail in the Frasch patent, differed from the method of such protection disclosed in the Grebe & Sanford patent. The probative effect of the Frasch patent as a printed publication,

adding to the public knowledge the use of hydrochloric acid under pressure to dissolve the limestone formation, including the removal of the dissolved formation, etc., was not considered by the Court in the *Williams Brothers* case. Plaintiff's argument therein, that the Frasch patent was nothing more than an abandoned experiment, caused the Court to come to an erroneous legal conclusion *based upon an assumption of facts in direct conflict with the proven and adjudged facts of the instant case.* The *Williams Brothers* decision ignores the fact—and the legal effect of the fact—that the Frasch patent made such method a part of the common knowledge, and that "diligence in unearthing prior patents which have not been turned into commercial success is not invention under the patent statute." (*W. H. Butcher Packing Co. v. Cincinnati B. S. Co.*—*supra.*) No evidence of the herein established fact that it was the Pure Oil Co. which was responsible for acidizing oil-wells, and not Grebe or Sanford or plaintiff, was before the Court in the *Williams Brothers* case. This fact is conclusively proven by the record before this Court (*Cf. supra*, pp. 66-69) and the District Court so found [F. F. 72—R. 1489]. And no evidence was before the Court in the *Williams Brothers* case that, following Pure Oil Co.'s acidizing of wells, others went into the business of successfully acidizing wells using ordinary available commercial hydrochloric acid [*Cf. supra*, pp. 74-84; and F. F. 79, 80—R. 1490]. While, in a footnote at p. 496 of 81 F. 2d giving a list of "many patents (which) have (been) issued, claiming processes using inhibited acids.", the Gravell patent appears, no other consideration is given thereto. The addition, by this Gravell patent, to the fund of public knowledge is not considered. The opinion states that:—

"What plaintiff did was to combine the Frasch idea of using acid to dissolve retaining limestone in an oil well, with the inhibited acids long used in the steel industry. Does that simple conception involve invention?" The opinion then states:– "At first blush, the conclusion seems irresistible that no inventive genius was employed in substituting an inhibited acid, long known in the steel industry, in the Frasch process." On rehearing, the Court admitted:– "The case is a close one; * * *" (p. 502). As a premise for its *arguendo*, the *Williams Brothers* opinion, p. 496, states:– "On the other hand, the stubborn fact remains that plaintiff was the first to solve a problem which has baffled all the scientific skill at the command of the oil industry for generations." The only evidence in the case upon which such statement could be grounded was in the self-serving recitals in the Grebe & Sanford patent [R. 1501, *ll.* 31-57], at least one of which (the alleged inoperativeness of the Frasch method), is proven false by the testimony and records in the case before this Court (*Cf. supra*, pp. 20-24), and has been found false by the District Court [F. F. 71 - R. 1488-9; *Cf.* 1462]. In the *Williams Brothers* case there was no evidence whatsoever respecting any use or attempted use *by anyone* of the Frasch method of acidizing wells. Successful use by Frasch and Van Dyke is established in the case at bar. The record in the *Williams Brothers* case is devoid of any proof that any scientific skill of anyone—connected with the oil industry or not—was devoted to, or that such worker ever considered, commercializing the Frasch process of acidizing oil-wells. So far as the record in that case or in the case at bar discloses, no one—skilled scientist or otherwise—connected with the oil industry or otherwise—ever knew of, possessed or consulted a copy

of the Frasch patent or attempted to use the Frasch method. There is not a scintilla of evidence in the *Williams Brothers* record or in the record in the case at bar that anyone having before him this full disclosure of the Frasch process of acidizing oil-wells, or having knowledge of the publicly known fact that the corrosive action of hydrochloric acid upon metals could be restrained or reduced by mixing with the acid one of the well-known corrosion-reducing agents, was "baffled" or failed to instantly realize and comprehend that, for Frasch's method of protecting the metal parts in an oil-well from the corrosive action of hydrochloric acid during its progress down into the cavity of the well, there could be substituted a corrosion-reducing agent mixed in the acid. The contrary is proven by the record [DX 151, "Conclusions," R. 1920-21]. Neither the record in said *Williams Brothers* case nor the record in the case at bar contains any evidence or proof whatsoever that any such problem was ever presented to anyone having actual knowledge of the Frasch process of acidizing wells or having a copy of the Frasch patent before him. No one of ordinary scientific or ordinary skill testified in either the *Williams Brothers* case or in the case at bar to having actual knowledge of the Frasch patent or to failing to instantly recognize that the corrosive action of the acid upon the metals could be reduced or inhibited by the use of well-known corrosion inhibitors. This error in the *arguendo* of the *Williams Brothers* opinion arises from the assumption,—against any proven fact,—that anyone of scientific or other skill in the oil industry had any actual knowledge of the Frasch process or patent. The patent law, as a test of novelty and invention, provides that everything that is so constructively public knowledge is conclusively

presumed to have been before the alleged inventor when he conceived his invention. The Court is required to judge the issue of invention upon such irrebuttable presumption. (*Fry v. Rookwood Pottery Co.*, 90 F. 494; *Adams v. Galion Iron Wks. & Mfg. Co.*, 42 F. 2d 395, 397 – CCA 6; *W. H. Butcher Packing Co. v. Cincinnati B. S. Co.*, 35 F. 2d 567, 569 – CCA 10 – *supra*.) Fallaciously, the *Williams Brothers* opinion applies this irrebuttable presumption as a test of "the scientific skill at the command of the oil industry for generations", disregarding the actual fact of want of actual knowledge by even such oil-industry technicians of the Frasch patent or method. "In the absence of a showing that Hixon actually knew of West, no inference can be drawn from a failure upon the part of Hixon to vary his method to embody the teachings of West, when so far as we know, he may actually have known nothing of West." (*In re Stovall*, 63 F. 2d 985 – CCPA.) *Cf. Weston Elec. Inst. Corp. v. Dejur-Amsco Corp.* (CCA 2, Feb. 1943, 133 F. 2d 778.) Upon this error the opinion predicates its statement:– "* * * the stubborn fact remains that plaintiff was the first to solve a problem which has baffled all the scientific skill at the command of the oil industry for generations." This error also led the Court in the *Williams Brothers* case into its failure to appreciate the probative force and value of the evidence respecting the Gypsy Oil Co. use of hydrochloric acid containing Rodine No. 2 (*Cf. supra*, pp. 59-68),—particularly the real evidentiary import of the report of the Mellon Institute (*Cf. supra*, pp. 59-62). Wescott's report is a demonstration that in 1928 [R. 1111] control of the corrosive action of hydrochloric acid upon metals was a matter of common knowledge. It is a demonstration

that for such purpose it was common knowledge to use the well-known pickle control and that such agent did not prevent the dissolving function or effect of the acid upon the limestone to which it was applied.* To these facts, the principle of law has been applied in *Herman v. Youngstown*, 191 F. 579, 582, that whether or not the transfer of a device from one art to another and its adaptation to use therein, involves patentable invention, is essentially a question of fact. (*Cf. Phillips v. Detroit*, 111 US 604). In *Blake v. San Francisco*, 113 US 679, it is stated:– "It follows from this principle that, where the public has acquired in any way the right to use a machine or device for any particular purpose, it has the right to use it for all the like purposes to which it can be applied, and no one can take out a patent to cover the application of the device to a similar purpose." In *Cuno Engineering Corp. v. Automatic Devices Corp.*, 314 US 84, 91, this principle is stated:– "A new application of an old device may not be patented if the 'result claimed as new is the same in character as the original result' (Blake v. San Francisco, 113 US 679, 683, 28 L ed 1070, 1072, 5 S Ct 692) even though the new result had not before been contemplated." (citing cases). Even if it could be adjudged that the Gravell patent does not disclose the use of Gravell's inhibited acid to dissolve limestone formations in an oil-well, the fact remains that such patent discloses the mixing of an inhibiting agent with hydrochloric acid to prohibit or reduce its corrosive action on steel. It also discloses that the addition is "without

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*In the case at bar, the fact that when Pure Oil Co. decided to acidize wells and went to plaintiff to procure the acid, Grebe immediately suggested the addition of an inhibiting agent [R. 2001] is additional proof that no invention or discovery was required.

detriment to the acid solution *for the purpose to which it is intended*" [R. 1948, *li.* 45-9]. It is not invention, therefore, to merely use "for the purposes to which it was intended" such inhibited acid in the Frasch method of dissolving limestone formation in an oil-well. "It is well-settled by many decisions of this court, which it is unnecessary to quote from or to refer to in detail, that the application of an old process or machine to a similar or analogous subject, with no change in the manner of application and no result substantially distinct in its nature, will not sustain a patent, even if the new form of result has not before been contemplated." (citing cases). (*Pennsylvania Railroad Co. v. Locomotive Truck Co.*, 110 US 490.) While Dr. Wescott's report [R. 1908-21] makes no reference to the Frasch patent, it does show a knowledge that Gravell's company manufactured and sold inhibitors, —Rodines,—[R. 1914]. No problem was presented to Dr. Wescott. He had actual knowledge of the use of inhibitors. He stated:– "The commercial use of inhibitors for the protection of metals in acid solutions is not new." [R. 1916]. Having determined the chemical composition of the "gyp" [R. 1912-13], to him there remained no problem to be solved respecting the dissolution of the "gyp".* His report says:– "Since the scale was shown to consist mainly of calcium and magnesium carbonates, *the selection* of a solvent was *a simple* matter. * * *" [R. 1913]. "The

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*Dr. Wescott did not testify in the *Williams Brothers* case. He was called in the case at bar and testified [R. 1110-29] that the conclusions of the Tenth Circuit Court of Appeals as to the work he recommended were not correct, particularly as to whether experimentation was necessary to determine whether inhibited hydrochloric acid would react with the calcareous deposits in a well [R. 1116-19]; and as to whether the results obtained were contrary to the forecasts made in his report [R. 1117, 1120-21].

use of an acid in removing the scale involves the loss of some of the metal of the tubing casing and sucker rods by solution in the acid. The casing in the Glenn Pool field is old and probably more or less severely corroded in spots. The corrosion in areas subjected to scale deposition is probably slight as the scale forms a very efficient protective coating. There are available on the market, numerous patented materials called inhibitors which are used principally in the commercial pickling of iron and steel products to reduce the loss of metal by solution in the acid. Some of these materials are very efficient in their action in dilute acids. Among the most successful of the inhibitors are a series of materials called Rodines, manufactured by the American Chemical Paint Company, of Ambler, Pa. * * *" [R. 1914]. "The results given in Table 5 indicate that *perfect* protection to the steel could most probably be insured by the use of sufficient Rodine.* 'It would not be economical to do that however." [R. 1915]. He set forth his determinations of the cost of the treatment [R. 1917-18]. Gypsy Oil Co. found that: "Our question was whether it was saving enough money to justify the work." [R. 1109]. The company at that time "had more than two million barrels of Glenpool oil in storage. We foresaw a decrease in the market price and had no desire to increase our reserves and accordingly decided to delay further acidizing operations until we had either a shortage of that grade of oil or a more favorable market." [R. 1089].

Another error of fact, upon which the *Williams Brothers* opinion depends as an important factor in the rationale

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*Dr. Wescott here obviously refers to complete elimination of all corrosive action of the acid upon the steel.

of the opinion is the statement (81 F 2d 498):– "Yet its action for that purpose was exactly contrary to the prediction of the scientists, for it increased the deposit. If the outstanding scientists of the Mellon Research Laboratories forecast the exact opposite of the effect of this inhibited acid in the bottom of an oil well, it must be true that experimentation was necessary to prove that the idea of the inventor would work." On petition for rehearing, the Court admits its error (81 F. 2d 502). But the argument of the original opinion, predicated upon this error, continues upon the assumption that:– "Frasch, an experienced chemist seeking to solve the same problem, failed to conceive the last step which did away with the necessity of his cumbersome, expensive, and impracticable method of getting the acid to the limestone without ruining the casing or tubing;* the capable and practical scientists in the research departments of the great oil companies, confronted for many years with the problem *and the Frasch patent* and their knowledge of inhibited acids in other industries, never thought of this simple solution."** (p. 498). The record did not contain any proof whatever that either any scientist or any practical oil producer had ever seen or was confronted with the Frasch

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*There was no evidence whatsoever that Frasch had any knowledge of the use of any agent for reducing or inhibiting the corrosive action of hydrochloric acid upon metals, unless his statement [R. 1937, *l.* 30] "otherwise made proof against corrosion" be understood to include substituting as the method of protecting the metals, the mixing with the acid of a corrosion-reducing agent.

**There was no evidence that anyone in any of the research departments ever had discovered or knew of the Frasch patent or had any knowledge of inhibited acids in other industries. The fallacy of the factual argument illuminates the error of the Court's conclusion: "That such experienced men came close but missed is some evidence that inventive genius is involved."

patent. In the case at bar, the record likewise totally fails to show any such facts. The arguendo of the opinion states "The patentee expended substantial sums in demonstrating the utility of the invention before applying for the patent. Such experimentation was essential * * *." (81 F. 2d at 498) and speculates upon reasons for this assumed necessity. The conclusion that plaintiff expended any substantial sums in experimentation or that such experimentation was essential was based upon a misconception of the record in that case. However, in the case at bar, the positive proof is that no experimentation was necessary nor was any money ever expended in experimentation. The Pure Oil Company was the instigator of treatment of its wells with hydrochloric acid to increase production (*Cf. supra*, pp. 68, 69).

The Court's misapprehension of the facts in the *Williams Brothers* case is further emphasized by its statement (81 F. 2d 499):— "The inhibiting reagent alone could not dissolve the limestone: the acid without the inhibitor had proven a failure." There was no evidence before that Court that anyone had tried the acid treatment and that it had proved a failure. The Court must have relied upon the false representation in the Grebe & Sanford patent [R. 1501, *ll.* 43-56].

A further error in the Court's reasoning in this *Williams Brothers* opinion is apparent from considering its statement (81 F. 2d 499-500) that:— "Plaintiff's invention is only useful in oil retained in rock formations which HCl will dissolve: the Gypsy use was confined to wells in a sand which is impervious to HCl." The Grebe & Sanford patent is not limited to use in limestone formations [*Cf.* R. 1502, *ll.* 97-104]. Plaintiff contended in

this *Williams Brothers* case,—as it does in its brief here, p. 21, that the Gypsy Oil Company "was operating some oil wells in sandstone (predominantly silicious and not acid soluble) where plaintiff's process is useless." Accepting this interpretation, the patent claims are therefore broader than the alleged invention. The confusion in the *Williams Brothers* opinion, of the evidentiary import of this fact, in its reference to the Gypsy Oil Company's operations as "an unsuccessful and abandoned experiment," and its interpretation of "plaintiff's invention," led to specious reasoning. The Gypsy Company's use was successful in removing "gyp". Where it was used in a sandstone formation, the proof in the *Williams Brothers* case was uncertain and not definite respecting increase of production. The reason given was that the wells after treatment were pumped into a common lease tank and no actual measurement of production of the individual wells was made. Nevertheless, *Williams Brothers* were enjoined from using inhibited hydrochloric acid upon sandstone formations, which were only six per cent. soluble in the acid [Physical Exhibit PX 297, p. 31].* Actually *the process* is the same whether used to treat limestone or sandstone or to remove "gyp" scale [R. 1097-9]. Plaintiff's expert Lewis testified [R. 37]:- "Q —Well, in either case the method is the same in the sense that you perform the same physical operations in introducing acid into the well and causing it to penetrate the formation, and the only difference is that the effect of the acid will vary with different formations; is that correct? A.—Well, speaking broadly, I think that is correct." Plaintiff commonly uses the process to treat sandstone formations both to remove scale and to react with the limestone binder in sandstone. Plaintiff has advocated

and advertised the use of the process for sandstone formations [PXs 242, 243 – R. 1790-91].

If the Court's opinion is purged of its erroneous statements and assumptions of facts, the error of its decision becomes apparent.

The record in the case at bar disproves the assumptions of fact in the *Williams Brothers* opinion and demonstrates the fallacy thereof. The facts as found by the District Court herein [F. F. 65, 66, 67, 71, 74 – R. 1487-9] will support only a judgment of invalidity of the Grebe & Sanford patent for want of invention.

Long Felt Want and Commercial Success.

Evidence that a given machine or process has filled a long felt want or need and was commercially successful may be referred to only where all the other proof in the case leaves the question of invention in doubt. In *Slip Scarf Co. v. Wm. Filene's Sons Co.*, 289 Fed. 641, C.C.A. 1, the First Circuit Court of Appeals affirmed the refusal of the trial court to give "requests Nos. 20 and 21, relating to the jury's taking into consideration, on the question of invention, the difficulties existing before the invention that were overcome by the patented invention, that it filled a want not adequately filled before, that it became public and went into extensive use, that the trade acquiesced in the patent by taking licenses, etc., and that others had tried and failed to meet the difficulties," saying: "The rule is that the class of evidence above referred to is to be made use of in determining the question of invention only in a doubtful case. Duer v. Corbin Cabinet Co., 149 U.S. 216, 13 Sup. Ct. 850, 37 L. Ed. 707; McClain v. Ortmayer, 141 U.S. 419, 429, 12 Sup.

Ct. 76, 35 L. Ed. 800; American Salesbook Co. v. Carter-Crume Co. (C.C.) 125 Fed. 499."

"Here the question is not open to doubt, * * *". [Opinion, Sixth Circuit Court, R. 2059-60].

There is no evidence in the record that anyone who had knowledge of the Frasch patent or the Oil City Derrick publication ever tried or failed to make the Frasch process operate. There is no evidence in the record that anyone having such knowledge and knowledge of the use of inhibitors in hydrochloric acid, or the patents disclosing such inhibitors, ever attempted to and failed to successfully operate Frasch's process using hydrochloric acid containing an inhibiting re-agent to reduce the corrosive effect of the acid upon the metal equipment of the well. In the absence of such proof the doctrine of fulfillment of a long felt want is not applicable to this case. As said by this Court in *Toledo Pressed Steel Co. v. Standard Parts*, 307 U.S. 350, at 356: "But it does not appear that either was familiar with the relevant prior art."

Patentable novelty, originality or invention, cannot be ascribed to the use of that which was in fact public knowledge. The Frasch patent and the Oil City Derrick publication made acidizing part of the public knowledge. The Gravell and Benecke patents make the use of inhibitors part of the public knowledge. The fact that these patents and publications were in fact unknown to those skilled in the art does not remove them from the public domain. Nor would the fact that another actually invented such a process independent of knowledge of such Frasch patent

and publication would not make him the original or first inventor thereof under the Patent Statute. On the contrary, his invention was anticipated because it was a part of the public knowledge.

> "Bone may have been ignorant of them and his device may not have been their suggestion. They seem to have been unknown to American engineers, not even the interest of the controversy in the sixth circuit having developed their existence. From this local ignorance nothing can be deduced favorable to the patent. Its device having been described in printed publications, although in foreign countries, patentable novelty or originality cannot be asserted for it. Rev. Stat. Sec. 4886, Act of March 3, 1897, 29 Stat. at L. 692, chap. 391, Comp. Stat. Sec. 9430, 7 Fed. Stat. Anno. 2d ed. p. 23. Such is the provision of the law, and we cannot relax it in indulgence to what may seem the individual's merit." *Bone v. Marion County*, 251 U. S. p. 134 at p. 144.

See further *Tashjian v. Forderer Cornice Works*, 14 F. 2d 414, 415 (C. C. A. 9); *Ironclad Mfg. Co. v. Dairyman's Mfg. Co.*, 143 F. 512, 513 (C. C. A. 2); *Fry v. Rookwood Pottery Co.*, 90 F. 494.

> "Entirely irrespective of the matter of use, a man is not entitled to the reward given inventive genius, if his invention had theretofore been disclosed to the public through the public records of the Patent Office. The statute rewards invention, and not diligence in unearthing prior patents which have not been turned into commercial success." *W. H. Butcher Packing Co. v. Cincinnati B. S. Co.*, 35 F. 2d 567, 569 (C. C. A. 10).

Although the proof established that the Simmons patented method actually filled a long felt want (*Cf.* 98 F. 2d 436, at 439-40), this Court, in *Honolulu v. Halliburton*, 306 U.S. 550, held the Simmons patent anticipated by the Franklin patent (306 U.S. at 554, 562), although there was no proof that anyone had ever used the Franklin device for the performance of the Simmons method, and although the description in the Franklin patent was "to control flow and not to test productivity of strata reached before completion of wells, * * *" (p. 562). This Court said of the Franklin device: "Plainly, it may be used as a tester; for by its use the contents of the producing stratum, sealed off from the rest of the well and unimpeded in its entry into the rat-hole by pressure of the rotary mud, can be brought undiluted to the surface by a mechanism almost duplicating that shown by the patent in suit" (p. 554).

In the case at bar—as it did in the *Williams Brothers* case—plaintiff stresses commercial success of the method practised by plaintiff as evidence that invention was required to produce the Grebe & Sanford method.* Commercial success is not proof of invention. (*Lempco Products v. Timken*, 110 F. 2d 307 – CCA 6; *American Fruit Growers v. Brogdex*, 283 US 1; *Bulldog Elec. Prod. Co. v. General Elec. Co.*, 105 F. 2d 466, 468-9 – CCA 4.) The commercial success of acidizing oil-wells was due to the initiative of the Pure Oil

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*"The Court:— * * * now I wish I could have known at the beginning of this case that you conceded that that was what—without it your (*Williams Brothers*) decision would have been the other way. Mr. Wiles:—Oh, certainly." [R. 1460-61.]

Company in utilizing the Frasch method.* Plaintiff pays Pure Oil Co. $5.00 for every well which plaintiff acidizes (see article II. of contract, Jan. 31, 1933 [PX 369 – R. 1873 at 1874]; and article II. of contract, June 30, 1934 [PX 370 – R. 1877, at 1879].) In such Frasch method, plaintiff has simply substituted one means of preventing or reducing the corrosive action of the hydrochloric acid on the metals in the well, for the specific method of inhibiting such corrosion set forth in the Frasch patent, and in the publications, describing such method. Plaintiff is and was a powerful, wealthy corporation. It organized and operated complete service organizations for acidizing wells. It advertised such service. It is not possible, under the circumstances of the case, to even infer that, had not the acidizing of oil-wells been promoted by such wealthy corporation—placing its prestige behind such operation—, the general introduction of such process would have met with success. It must be borne in mind that plaintiff did not disclose what acid it was using. Its representation was that: "A new process of injecting acid into oil wells . . . was announced this week by the Dow officials." [R. 1626 – *Cf. supra*, p. 71]. Its advertisements did not disclose what the new process was [*Cf.* letters – R. 1623, 1618-21]. In order to introduce its "new process of injecting acid into oil wells", plaintiff found it necessary to make an agreement with The Empire Oil and Refining Company by which plaintiff selected ten wells for treatment and agreed to take as payment "$300.00 per well out of one-half of seven-eighths of the

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*"The Court: * * * I take it that you do not dispute that this witness right here for the Pure Oil Co. went there to get the well treated—is that right? Do you dispute that? They took the initiative in that regard? Is that disputed at all? Mr. Owen:—No." [R. 1021.]

increased production", etc. [*Cf.* agreement Dec. 14, 1932, between "The Empire Companies" and plaintiff – R. 1622]. The financial responsibility and prestige of plaintiff, its advertising, its inducement of use of the method by assuming the risk of financial loss, and its willingness and ability to depend upon the money results, were each vital factors in the exploitation by plaintiff of acidizing oil wells. (*Cf. Piston Ring Co. v. Burd High Comp. R. Co.*, 276 F. 357, 367 – CCA 7.) The controlling fact is that creation or use of acidizing wells presented no problem requiring invention or discovery. This is conclusively proven, not only by Dr. Wescott's statement, "the selection of a solvent was a simple matter", and that the inhibition of corrosion by hydrochloric acid was well-known [R. 1913-14], but by the facts attending Pure Oil Co.'s initiation of the acidizing of wells, when Thomas (Pure Oil Co.) applied to plaintiff for hydrochloric acid. Grebe immediately, from his knowledge of corrosion inhibition, suggested the addition to the acid of a corrosion inhibitor [R. 2001]. The case is devoid of any proof that this involved anything more than Grebe's knowledge of the chemical action of inhibitors.

"Further, it is settled that articles may be new in a commercial sense, when they are not new in the sense of the patent law (*Collar Co. v. Van Deusen*, 23 Wall 530, 23 L. Ed. 128), and novelty, however great, can never be put in the place of invention (*Robins v. Link Belt Co.*, 233 Fed. 1005, 148 C.C.A. 15.) The fact that a patented device has had enormous sales does not dispense with all other evidence of invention." *Boston Pencil Pointer Co. v. Automatic Pencil Sharpener Co.*, 276 Fed. 910, 912, C.C.A. 2; *Cf. Reed v. Coe*, 132 F. 2d 599, 600, C.A.D.C.; *Grant v. Walter*, 148 U.S. 547, 554; Amdur's Patent Law and Practice, Sec. 74, p. 173.

BRIEF ON THE QUESTION OF INFRINGEMENT.

The issue of infringement is before this Court upon defendant's cross petition.

Even without Certiorari on defendant's cross-petition, the defense of non-infringement is before the Court for adjudication. *Langnes v. Green*, 282 U.S. 531, 535 *et seq.*; *Stelos Co. v. Hosiery Motor-Mend Corp*, 295 U.S. 237, 239. Defendant does not challenge the findings of the District Court respecting how defendant protects its transportation tanks or the fact that in so doing the hydrochloric acid picks up minute amounts of chlorides which to some extent reduce the corrosiveness of the acid during its progress down the well. Defendant does, however, contend that this practice should not be held to constitute an infringement of the patent in suit.

Defendant first (in 1935) treated oil wells with hydrochloric acid and used steel tanks to transport the acid. Steel tanks are a practical necessity. Glass carboys cannot be economically used. Some means was necessarily employed to protect the tanks from corrosion. When defendant first operated, it used a corrosion reducing agent to protect its steel tanks; the agent principally used was Rodine or murodine [R. 256, 260] manufactured by the American Chemical Paint Co. [R. 980], the then owner of the Gravell patent 1,678,775 [R. 1947]. At that time the Grebe & Sanford patent had been adjudged invalid by the District Court in the Williams Bros. case. Upon the

reversal in January, 1936 of this judgment, defendant without incurring liability under the Tenth Circuit Court's decision, could no longer use the old Gravell method of protecting its tanks in transporting the acid to the wells. Therefore, defendant ceased acidizing wells [R. 262].

In June, 1936, defendant again started acidizing oil wells without, however, using Rodine or any other corrosion reducing substance in its acid. It used steel transportation tanks to haul its acid to the wells. To protect its steel transportation tanks against the corrosive action of the acid defendant invented and used an electrical system which involves the use of a lead plate as an electrode bonded to the interior of the steel tank, for which, on March 7, 1939, the Menaul patent 2,149,617 was granted [R. 263], (Physical Exhibit 191). It added no corrosion reducing substance to its acid. In its steel transportation tanks it attached the lead plates, described in the Menaul patent 2,149,617, to the inside of the tanks to provide an electrical arrangement to protect the steel of the tank against corrosion by the acid [R. 267]. In so handling the acid defendant used the usual steel tubing brass valves and fittings. There may have been some bronze in the pumps used [R. 386]. Like all steel, the steel of the tanks contained a small percentage of copper [R. 616, 390]. As the result of this handling and transportation, minute quantities of metal (iron, lead and copper) became dissolved as metal chlorides in the acid [R. 388-9].

Both the District Court and the Court of Appeals adjudged defendant's operations infringement. This determination was based upon plaintiff's assertion of the scope of the Grebe & Sanford claims extending to any inhibition of the corrosive action of the acid without regard to how such inhibition was secured or the amount of the inhibiting agent used. It is defendant's position that the Grebe & Sanford patent claims (if valid) are not entitled to such scope; that properly interpreted the patent explains the invention as consisting in the use of an agent which is added to the hydrochloric acid to prevent the dissolving action of the acid upon metals, and particularly upon steel or iron, copper, etc.; that the correct interpretation of the scope of the Grebe & Sanford patent is to restrict the claimed invention to the use of an inhibited acid which does not attack (dissolve) metal surfaces. Defendant employs ordinary commercial hydrochloric acid to which no inhibitor is added and which in attacking the steel tank and lead plate forms the inhibiting substances complained of by plaintiff.

The Grebe & Sanford patent specifies the addition to the hydrochloric acid of "a small amount of a substance capable of inhibiting attack of the acid upon metal surfaces, *e. g.*, of iron, or steel, copper, etc., with which it comes in contact." [R. 1501, *ll.* 75-78]. The purpose of adding such a substance to the acid is set forth in *ll.* 48-56. Nowhere in the patent is there even an intimation that the corrosive action of the acid may be prohibited or even lessened in any other manner than by adding such a substance *as will not attack (dissolve)*

metal surfaces. Therefore, according to the teaching of this patent, the substance added to the acid as an inhibitor must not attack (dissolve) metal surfaces and a reasonable interpretation of the patent's terms excludes any corrosion inhibition of the acid which is secured in any other manner than by adding such a substance as will not attack (dissolve) metal surfaces.

It is to be noted in this connection that the patent contains no reference whatsoever to either copper or iron or lead or the chlorides of either of these being utilizable as an inhibiting agent or substance (arsenic, etc. named in the patent) to reduce the corrosion (dissolving) of copper, iron or steel, etc.

Notwithstanding this, the adjudication of infringement is founded upon the "minute quantities of copper, iron and lead chlorides (which) are deposited on the inside of the steel container, forming a protective coating." [C.C.A. 6 Opinion, R. 2054.]

Metallic chlorides produced in the acid by dissolving metals are not the equivalent of the substances disclosed by the Grebe & Sanford patent to be added to the acid to prevent the attack of the acid upon metals, thereby producing the metallic chlorides. As said by this Court in *Goodyear Dental Vulcanite Co. v. Davis,* 102 U. S. 222 at 227: "This construction of the patent is confirmed by the avowed understanding of the patentee, expressed by him, or on his half, when his application for the original patent was pending. * * * But when a patent bears on its face a particular construction, inasmuch as the specification and claim are in the words of the patentee, it is reasonable to hold that such a construction may be confirmed by what the patentee said when he was making his application."

Plaintiff Disclaimed Metallic Chlorides as the Equivalent of the Specified Substances.

On *August 8, 1932* [R. 2026], in its first action on the Grebe & Sanford application, the Patent Office rejected claims 1, 5, 7, 8 and 9 here in suit, because of the inevitable presence of chlorides in the acid, and made of record the patents to Muehl [R. 1546], Lake *et al.* [R. 1549], Tilton [R. 1553], Ranney *et al.* [R. 1565], and a patent to Coggeshall and two De Groot patents (not reproduced in record herein). On August 12, 1932 plaintiff's attorneys had an oral interview with the Patent Office Examiner [R. 2027] and filed a brief [R. 2027-38] discussing from plaintiff's standpoint the prior patents so made of record. This brief states [R. 2028]:— "The utility of hydrochloric acid treatment in increasing the flow of an oil well was first pointed out by Frasch in United States Patent 556,669 in 1896, but this method has never found general application due to the danger of corroding metal apparatus within the well. Present applicants have found and are first to find that any of a wide variety of inhibiting agents may be added to hydrochloric acid to prevent its attack upon metal surfaces within a well and that the so-treated acid may be employed to increase the flow of a well without danger of corroding metal surfaces within the same." In this brief metallic chlorides (the agents charged to infringe here) were specifically disclaimed as inhibitors:— *"Neither sodium chloride nor other metallic chloride may be employed successfully to inhibit the action of hydrochloric acid upon iron or steel and if they could be so employed they would,* at the same time, *inhibit* the *action of said acid upon the calcareous rock with which it is intended that it shall react.* **Metallic chlorides, then, cannot be employed in place of the inhibitors disclosed in the application,** hence the fact

that such chlorides are sometimes present within a well does not invalidate patentability of any claim in the application." [R. 2036, italics reproduced from brief, boldface emphasis supplied]. This statement was supported by affidavit of Grebe [R. 2038-9] stating certain experiments made in order to compare the utility of various corrosion inhibitors disclosed in the Grebe & Sanford application, as agents to prevent attack of aqueous hydrochloric acid upon iron, with the utility of sodium chloride for similar purposes.

Thus plaintiff disclaimed all metallic chlorides as inhibiting agents or substances within the scope of the asserted invention sought to be patented and thus eliminated from the patent those chlorides (upon which the charge of infringement is based) which were thus excluded as equivalent inhibiting agents by this surrender of scope and definition of the claimed invention. *Wright v Yuengling*, 155 U.S. 47; *Roemer v. Peddie*, 132 U.S. 313; *Greene v. Buckley*, 135 Fed. 520, C.C.A. 2; *Wilson & Willard Mfg. Co. v. Union Tool Co.*, 249 Fed. 729, 735, C.C.A. 9.

To hold the presence of metallic chlorides in defendant's acid constitutes an inhibiting substance in infringement of the patent is to extend the claims to cover that which was expressly disclaimed in the Patent Office. The law does not permit this. "It follows that what the patentee, by a strict construction of the claim, has disclaimed * * * cannot now be regained by recourse to the doctrine of equivalents * * *." *Exhibits Supply Co. v. Ace Patents Corp.*, 315 U.S. 126, 137. The Court of Appeals does not discuss, and apparently overlooked, plaintiff's disclaimer that metallic chlorides cannot be employed in the place of the inhibitors disclosed in the patent.

The Infinitesimal Amount of Copper Chloride Present in Defendant's Tank Acid Does Not Fall Within Any Range of Inhibiting Agent Required Under the Patent Disclosure.

Plaintiff was forced to concede at the trial that any commercial hydrochloric acid contains some of the very copper and lead chlorides the presence of which in defendant's acid is complained of [R. 373, 347]. These results from the contact of the acid during its manufacture with the pipes, pumps, etc. in which the acid is handled, just as they do during transportation to the wells from the contact in the steel tanks with the metal walls and lead plates.

At the trial plaintiff conceded that the Grebe & Sanford claims are not infringed if they are interpreted to include a small amount of inhibiting agent or to include the degree or amount of corrosion reduction resultant from the small amount of inhibiting agent normally present in commercial hydrochloric acid [R. 347, 373]. Immediately this suggests the question: How do the claims distinguish from such small amount of agent or such small degree of corrosion reduction? The method is the same, whether the agent occurs naturally, or incidental to the manufacture of the acid, or is formed thereafter, and irrespective of what amount of corrosive action is prohibited. The Grebe & Sanford patent claims do not disclose or define to what extent corrosion by the acid must be reduced in order to fall within the claimed invention and distinguish it from the degree of reduction of corrosion incident to the inhibiting agents forming a part of such commercial hydrochloric acid. In this respect the claims fail utterly to distinguish between the old and what is claimed to be the new. Also the claims call for the

presence in the acid of "a relatively small amount" of the corrosion-reducing agent. No standard of comparison is contained in the description of the patent, and no disclosure or definition of what is "a relatively small amount" is contained in the claims. The claims do not comply with the requirements of *R. S. 4888 (35 USCA, Sec. 33)*, which specifically requires that the applicant for a patent shall "particularly point out and distinctly claim the part, improvement, or combination which he claims as his invention or discovery." The reasons for this statutory requirement have been restated by this Court as recently as May, 1938 in the case of *General Elec. Co. v Wabash Appliance Corp.*, 304 US 364, 369. "But the vice of a functional claim exists not only when a claim is 'wholly' functional, if that is ever true, but also when the inventor is painstaking when he recites what has already been seen, *and then uses conveniently functional language at the exact point of novelty.*" [pp. 370-71]. *Cf. Germer Stove Co. v. Art Stove Co.*, 150 F. 141, 144, 145; *National Theatre Supply Co. v. Da-Lite Screen Co.*, 86 F. 2d 454, 455 (C.C.A. 7); *American Lava Co. v. Steward*, 155 F. 731, 736; *Farmers Cooperative Exchange v. Turnbow*, 111 F. 2d 728, 731-2 (C.C.A. 9).

The claims of the Grebe & Sanford patent are not limited in terms to an acid solution containing 1 to 5 per cent. of corrosion-reducing or inhibiting agents. They are wholly indefinite with respect to any proportions. They are therefore invalid. If they could be limited by the patent specification, then defendant would not infringe. Plaintiff has admitted that defendant's acid does not contain 1 to 5 per cent. of an inhibitor [R. 364, 366].

Compared with the corrosiveness of chemically pure hydrochloric acid, the corrosiveness of ordinary commercial hydrochloric acid is reduced by the inhibiting agent, present therein, resultant in its manufacture. The degree of such reduction or inhibition is not as great as the reduction or inhibition by the addition of an arsenic compound in an amount equal to one to five per cent. by weight of the acid solution. Plaintiff conceded at the trial that at no time did defendant's acid contain one to five per cent. of anything which plaintiff claimed to be an inhibitor [R. 364]. Plaintiff conceded that defendant's acid did not contain as much as 1/25th of one per cent. of inhibiting substances [R. 364; *Cf.* Bartell – 366]. Plaintiff's witness Bartell testifies that some commercial hydrochloric acid contains substances or "impurities" inhibiting or reducing its corrosivness 15 to 18 per cent. [R. 352-3, 441, 469-70]. Such a 15-per-cent. inhibited commercial acid is 85 per cent. as active as chemically pure hydrochloric acid. The solution referred to in the patent description [p. 2, *ll.* 72-4 – R. 1502] is reported by Bartell to give "a reduction in corrosiveness of 97 per cent." This is "a corrosiveness of 3 per cent. (of) that of the C.P. (chemically pure) acid." [441.]* "So, on that basis the acid [Detroit Chemical Works commercial acid – *Cf.* R. 352-3] showing 85 per cent. corrosion would be about 28 times as active as one showing 3 per cent. corrosion." [Pat. p. 2, *ll.* 92-4 – *supra*; R. 441]. According to Bartell's testimony [R. 439] defendant's acid is 17 times as active as the inhibited acid of the patent in suit. The Grebe & Sanford patent uses the terms,

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*Plaintiff's publication, "The Acidizer," April, 1939, states that plaintiff's Dowell inhibitor gives 99 per cent. reduction in corrosiveness. [R. 442.]

"largely or substantially inhibited" [R. 1502, *l.* 15], "no *substantial* attack upon the pump tube," [*Id.* 25-6], and "without *appreciable* damage to the pump tube or well casing" [*Id.* 96-7]. Bartell admits [R. 467-79] that there is nothing in the patent to indicate whether or not one acid is largely or substantially inhibited with respect to another or to give any definiteness of meaning to these terms "largely", "substantially", "appreciably", used in the patent; that the term "substantially", so used, might correctly be applied to the reduction in corrosiveness existent in commercial acid as compared with chemically pure acid, as well as to defendant's acid, or to the one to five per cent. of an arsenic compound acid of the patent [R. 467-70]; that the patent does not give any quantitative figure or quantitative value for the amount of the inhibitor that may be allowed within commercial hydrochloric acid, if commercial acid could be assumed as intended to be referred to in the patent [473].

According to Bartell's testimony [R. 381, 437, 377, 429-30], defendant's acid contains:– *Copper:* Stella Wilcox sample No. 6 – 3.6 parts per million, or 0.00036% [437]; Zahn – 0.00031% [437]; Crawford – 0.00048% 437]. *Iron:* Stella Wilcox No. 6 - 0.0473% [437]; Zahn – 0.0380% [437]; Crawford – 0.0210% [437]. *Lead:* Stella Wilcox No. 6 – 0.04017% [437]; Zahn – 0.0435% [437]; Crawford – 0.0053%. [*Cf.* PX 160, R. 1711.] Iron reduces corrosion little or none [R. 379, 505]. "The iron doesn't seem to make much difference." R. 404.] *Cf.* 398-9, 401, 403. Bartell [R. 392] says:– "As we have shown, the ferrous iron has apparently no inhibiting action; if it happens to be in the ferric form it might have a slight inhibiting action." The charge of infringement is based essentially on the copper chloride

found in defendant's acid [R. 378-80, 389, 390, 406, 505, 525, 614]. Some of the copper presumably came from the bronze and brass fittings and pump. It may have come from most anywhere [R. 382-3, 386]. The copper chloride got into the acid only as the result of the normal handling of the acid with defendant's equipment [R. 387-9]. Most of the copper probably came from the steel of the tank used to haul the acid to the well [R. 387-90, 661, 665, 669, 670, 674, 675]. All steel contains some copper [R. 616]; tank steel perhaps more than any other steel [R. 661, 674, 675]. Defendant bought one of the purest commercial acids on the market [R. 380]; it contained some copper chloride [about one-fourth the total amount found in the acid at the wells – R. 1713] and other impurities, which reduced its corrosiveness. All commercial acids are known to contain some inhibitors [R. 367, 398], even including arsenic compounds [R. 1081, 1082]. Plaintiff's expert Dr. Prutton testified [R. 525]:– "As has been reported by myself and Dr. Bartell, the copper is the vital element in the inhibition." [*Cf.* R. 614.] "*Yes, the copper is the effective agent, there is no question about that.*" [Plaintiff's counsel, Mr. Owen – R. 406]. Bartell concludes that the corrosiveness of defendant's acid is reduced to 53% of the corrosiveness of chemically pure hydrochloric acid,—47% reduction in corrosiveness [*Cf.* R. 338-39]. Bartell testified that defendant's acid is 53 times as active as plaintiff's according to the representations in plaintiff's advertising that its acid is 99% inhibited [R. 442].

3.6 parts per million is an infinitesimal amount of copper. It is 36/1000ths of 1/100th of 1% of the whole solution,—not one to five per cent. by weight of the hydrochloric acid solution as comprehended by the patent

[R. 1502, *ll.* 73-4]. Bartell testifies this infinitesimal amount of copper reduces the corrosiveness of the hydrochloric acid solution 33 per cent. [R. 407, 429-30]. Available commercial hydrochloric acid has its corrosiveness reduced 15% to 18% (Detroit Chemical Co's commercial acid). [R. 353-5]. The claim of the patent does not refer to *reduction* in corrosiveness [R. 369]. Plaintiff's position before the Trial Court was that the patent claimed only the effect, and was not limited to any degree of reduction of corrosiveness [R. 366-7].

Defendant's tank acid has its corrosiveness reduced 42 per cent [R. 338]. There is no definition in the Grebe & Sanford patent of the degree of reduction of corrosiveness which is required to bring the operation within the purported invention [*Cf.* R. 355-95, 361; F.F. 87, R. 1491].

Some of these minute amounts of copper, lead and iron chlorides found in defendant's transportation tanks were "incidental to the operation of defendant's method of protecting its transportation tanks." [F.F. 90 – *Id.*] But plaintiff seeks to enjoin defendant from hauling acid to the wells in steel tanks, whether lead plates are used to protect the tanks or not [R. 389-90].

According to Bartell's testimony, the iron, lead and copper that he found in defendant's tank acid was produced by the action of the hydrochloric acid upon the tanks and equipment. Such action was a dissolution of these metals into chlorides,—iron chloride, lead chloride and copper chloride. The proven fact is that the hydrochloric acid attacks the metals and produces these chlorides, *instead* of there being in defendant's acid any "substance capable of inhibiting attack of the acid upon metal surfaces, *e. g.* of iron or steel, copper, etc., with which it comes in contact," —the stated object of the allegedly new method.

If the claims can be sustained as particularly pointing out and distinctly claiming the invention (*R.S. 4888 – 35 U.S.C.A., Sec. 33*) this can be done only by restriction of the claims to an amount of agent substantially equal to the "1 to 5 per cent of the arsenic compound" or of the other agents catalogued in the patent. To adjudge thirty-six one-thousandths of one one-hundredth of 1 per cent of inhibiting agent the "equivalent" of "1 to 5 per cent" is to eliminate any substantial distinction between a Grebe and Sanford inhibited acid and commercial acid. To sustain plaintiff's interpretation of the scope of the patent claims, is to establish in plaintiff a monopoly of inhibiting the corrosive action of the hydrochloric acid upon the metal equipment of the well regardless of how such inhibition is secured or to what degree the corrosion is reduced.

Conclusion.

It is respectfully submitted that the decree dismissing the suit should be affirmed both upon the ground that the Grebe & Sanford patent is invalid and upon the ground that the use of metallic chlorides (of iron, copper and lead) are not in law equivalents of the inhibiting substances disclosed and claimed in the Grebe & Sanford patent.

Respectfully submitted,

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SUPREME COURT OF THE UNITED STATES.

Nos. 50 and 61.—October Term, 1944.

The Dow Chemical Company, Petitioner, *vs.* Halliburton Oil Well Cementing Company.	On Writs of Certiorari to the United States Circuit Court of Appeals for the Sixth Circuit.
Halliburton Oil Well Cementing Company, Petitioner, *vs.* The Dow Chemical Company.	

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[March 5, 1945.]

Mr. Justice Murphy delivered the opinion of the Court.

In issue here is the validity of United States Patent No. 1,877,504, relating to "the treatment of deep wells, such as oil, gas, brine or water wells, to increase the output therefrom," issued to John J. Grebe and Ross T. Sanford on September 12, 1932.

Petitioner, the owner of the patent, brought this suit against respondent for alleged infringement. Both the District Court for the Eastern District of Michigan and the Sixth Circuit Court of Appeals held the patent invalid for want of invention and denied relief. 139 F. 2d 473. Previously the Tenth Circuit Court of Appeals, in reversing the judgment of the District Court for the Northern District of Oklahoma, had held the patent valid and infringed in a suit brought by petitioner against another party. *Dow Chemical Co.* v. *Williams Bros. Well Treating Corp.*, 81 F. 2d 495, cert. denied, 298 U. S. 690. The conflicting views of the appellate courts concerning the validity of the same patent led us to grant certiorari in this case, 322 U. S. 719, and oblige us to decide independently the factual issue of validity. *Universal Oil Co.* v. *Globe Co.*, 322 U. S. 471, 473.

The stated object of the Grebe-Sanford patent is "to counteract some preventable natural causes for the decline of yield of a well" where the well has been drilled into a limestone or other calcareous formation. As oil is pumped from a well, the under-

ground flow to the well decreases and the yield declines until pumping is no longer profitable. Yet it is known that when that point is reached there often remains embedded in the rock formation a great deal of oil unrecoverable by ordinary processes. Many methods have been suggested to recover this hidden oil. The forcing of water or gas into the rock formation, the heating of the surrounding rock and the use of explosives have all been proposed but found wanting in one way or another.

Eventually, however, the idea was conceived of using acid to dissolve the limestone, thus opening channels through which the oil could flow into the well. This idea first appears to have been developed in United States Patent No. 556,669, issued on March 17, 1896, to Herman Frasch, with a half interest being assigned to John W. Van Dyke. The essence of this patent was the introduction into the oil well of a large solution of hydrochloric acid under pressure, with fresh water being added later to force the acid further into the limestone. Frasch recommended the use of commercial hydrochloric acid containing from 30% to 40% by weight of the acid gas HCl; he further recommended that the acid remain in the well for twelve hours. A suitably arranged packer was to be used to confine the acid to the lower or oil-yielding portion of the well hole.

Frasch also recognized that the hydrochloric acid was likely to corrode the metal well equipment. Hence the patent suggested that the regular well tubing be removed and that an enameled or lead-lined pipe be inserted to conduct the acid down into the well, "or it may be otherwise made proof against corrosion." An additional suggestion was that an alkaline liquid be introduced to neutralize the acid after it had performed its function.

Frasch's method proved successful in disintegrating limestone rock and increasing the flow of oil. The record shows that at least fourteen commercial wells near Lima, Ohio, were treated with this process in 1895 and 1896, resulting in substantial production increases in most instances. Wide publicity was given to these operations. But despite this success, Frasch and Van Dyke soon discontinued their work along these lines. The reasons for this abandonment are not clearly disclosed by the record. Respondent suggests personal reasons on the part of Frasch and Van Dyke and claims that the relatively undeveloped oil industry at that time had little use for such an invention. Petitioner, how-

ever, contends that Frasch's method was so cumbersome and expensive that it was commercially impracticable;[1] such is also the reason advanced by the court in the *Williams Bros.* case, 81 F. 2d at 496.

Whatever the reason for the failure of the Frasch method to achieve wide-spread use, the Grebe-Sanford patent in issue claims to be an improved method of treating wells with a hydrochloric acid solution. The patent expressly recognizes the Frasch treatment but states that it was never generally adopted "due to the fact that the acid attacks the metallic casing, pump tube, etc. about as actively as the rock, and causes serious damage thereto." To meet this alleged defect, the Grebe-Sanford patent proposes the use of a hydrochloric acid solution containing "a small amount of a substance capable of inhibiting attack of the acid upon metal surfaces . . . with which it comes in contact." The preferred inhibiting agent is one of several specified arsenic compounds, to be added in the amount of from 1% to 5% of the weight of the solution. Numerous other inhibitors are also suggested. The patent further states that "the strength of the aqueous hydrochloric acid solution, in general best adapted to the purpose in hand, may be between about 5 per cent and about 20 per cent, and preferably should be between 10 and 15 per cent although other concentrations may be used, if desired." Claim 8 (claims 1, 5, 7, 8 and 9 are in issue) best sums up the preferred form of the Grebe-Sanford process:

"The method for increasing the output of an oil well which comprises charging into the pump tube a quantity of a 5 to 20 per cent hydrochloric acid solution containing a relatively small amount of a corrosion inhibitor, expelling the acid from the tube into the bore of the well by applying pressure thereon, permitting the acid to act upon the rock formation surrounding the well cavity and withdrawing the spent acid."

The parties differ as to the precise scope of the alleged patentable improvement over the Frasch method of acidizing wells. Respondent urges, and the two courts below held, that the sole object

[1] Petitioner argues that (1) Frasch used concentrated acid that was so corrosive as to compel the use of the costly and cumbersome expedient of removing the ordinary well tube and inserting a special acid supply pipe; (2) concentrated acid being less effective than diluted acid in reacting on the limestone rock, the production increases achieved by Frasch were too small to justify the expense of the treatment; and (3) viscous spent acid was difficult to remove under the Frasch method from the pores of the rock and hence blocked or lessened the flow of oil to the well hole.

of the Grebe-Sanford process is simply to protect the well equipment from corrosion by adding an inhibiting agent to the hydrochloric acid solution.[2] Petitioner has consistently claimed, on the other hand, that the patent specifies three novel points which elevate the described process to the level of an invention: (1) the addition of an inhibiting agent to the hydrochloric acid solution to prevent corrosion; (2) the use of a dilute rather than a concentrated hydrochloric acid solution; and (3) the use of the ordinary pump tube instead of a specially protected supply pipe to introduce the acid into the well. Assuming without deciding that petitioner's version of the alleged improvement is correct, however, we hold that no one of these three claims and no combination thereof evidences that degree of skill and ingenuity which constitutes the essential ingredient of a true invention.

(1) *The addition of an inhibiting agent.* It is clear that the Grebe-Sanford suggestion that an inhibiting agent, preferably an arsenic compound, be added to the hydrochloric acid solution presents no patentable advance over the prior art. Petitioner makes no claim that the inhibiting agent in any way affects the chemical action of the acid on the limestone rock; it states merely that the inhibitor acts so as to prevent or restrict the corrosive effect of the acid on the metal well tubing and equipment. But long before the Grebe-Sanford process was patented it had been known that inhibiting agents could be used to protect metals from acid solutions. More particularly, it was well known that arsenic compounds mixed with hydrochloric acid solutions acted as effective inhibitors and numerous patents embodying that principle had been granted.[3] Various inhibitors were available on the market at the time of the conception of the Grebe-Sanford process and

[2] One of petitioner's experts testified that the main claim of the Grebe-Sanford patent is the addition to the hydrochloric acid of some material which will inhibit the action of the acid and that the claimed result "would be limited apparently to the equipment, rather than to the well itself." He stated further that the suggested inhibitors "would have no effect on the acid in connection with its reaction upon limestone" and that they "have a specific function on the metal equipment used in connection with the well treatment."

[3] See, for example, Patent to Beneker, No. 914,916 (1909); Patent to Gravell, No. 1,678,775 (1928). For patents involving the use of inhibitors other than arsenic compounds, see Patent to Holmes, No. 1,470,225 (1923); Patent to Rhodes, No. 1,746,677 (1930); Patent to Rhodes, No. 1,746,678 (1930); Patent to Vignos, No. 1,750,651 (1930); Patent to Harrison, No. 1,766,902 (1930); Patent to Corson, No. 1,773,953 (1930); Patent to Calcott, No. 1,785,513 (1930); Patent to Burke, No. 1,789,805 (1931).

were used extensively in the commercial pickling of iron and steel products in acid solutions and in the transportation of acids in metal containers.

There was evidence, moreover, that in 1928 and 1929 the Gypsy Oil Company had successfully used inhibited hydrochloric acid to remove scale from certain of its oil wells drilled in sandstone formations. This process was based upon a report made on behalf of the Mellon Institute at Pittsburgh at the request of the Gypsy Oil Company, which had been bothered by the formation of scale on the metal well equipment. The report, after noting that "the selection of a solvent was a simple matter" and that "the commercial use of inhibitors for the protection of metals in acid solutions is not new," recommended the removal of the scale by the use of a hydrochloric acid solution treated with an inhibitor obtainable on the market. Even if petitioner be correct in labeling this Gypsy Oil Company use as an abandoned experiment not amounting to anticipation, it is significant that the use of an inhibitor to check the hydrochloric acid from corroding the metal well equipment while attacking the scale suggested itself without trouble.

Thus prior to the patenting of the Grebe-Sanford process in 1932 the following facts were manifest and elementary to any one skilled in the art: (a) hydrochloric acid would dissolve limestone and increase the production of oil wells, as demonstrated by the Frasch patent; (b) hydrochloric acid would also corrode metal with which it came in contact; (c) arsenic compounds and other chemicals could be added to hydrochloric acid to inhibit this corrosive effect; and (d) inhibited hydrochloric acid could effectively be utilized to remove scale from metal well equipment without corroding the metal. A representative of the Pure Oil Company then suggested to Grebe and Sanford the possibility of acidizing oil wells to increase production. The latter, from their knowledge of brine-well acidizing and of corrosion inhibition, immediately recommended the use of hydrochloric acid containing an inhibitor. Grebe and Sanford at this time apparently did not know about the Frasch patent. But spurred by the suggestion of the Pure Oil Company, they worked out the process in issue on the basis of known facts and reactions.

All the Grebe-Sanford process taught was the obvious fact that hydrochloric acid could be inhibited to prevent corrosion while

being used to dissolve limestone rock pursuant to the Frasch method of acidizing wells. No new mental or physical operation was required to add, as suggested by the Grebe-Sanford process, an arsenic compound of from 1% to 5% of the weight of a hydrochloric acid solution. No new or unexpected results were obtained by the addition of such an inhibitor. It was perfectly plain to an expert that the metal well equipment would thereby be protected from corrosion. The Grebe-Sanford method, in short, involved in this respect no more than a mere application of an old process of inhibition to a new and analogous use of protecting metal well equipment from corrosion when the well is being acidized to increase production. Such a process lacks the very essence of an invention. See *Electric Cable Co.* v. *Brooklyn Edison Co.*, 292 U. S. 69, 79, 80; *Paramount Publix Corp.* v. *American Tri-Ergon Corp.*, 294 U. S. 464, 473; *Cuno Engineering Corp.* v. *Automatic Devices Corp.*, 314 U. S. 84, 89.

The fact that prior to 1932 no one had apparently thought to use an inhibitor while acidizing an oil well to increase production cannot inject into the Grebe-Sanford process the attributes of an invention. Especially is this so since there is no evidence of any one trying unsuccessfully to inhibit hydrochloric acid for such purposes. He who is merely the first to utilize the existing fund of public knowledge for new and obvious purposes must be satisfied with whatever fame, personal satisfaction or commercial success he may be able to achieve. Patent monopolies, with all their significant economic and social consequences, are not reserved for those who contribute so insubstantially to that fund of public knowledge.

(2) *The use of a dilute rather than a concentrated hydrochloric acid solution.* Petitioner lays great stress on the fact that the Grebe-Sanford process suggests the use of a dilute hydrochloric acid solution containing only 5% to 20% HCl (preferably 10% to 15%). It is pointed out that Frasch's patent called for the use of commercial hydrochloric acid, which contains from 30% to 40% of HCl, and that in some of his treatments from 27% to 28% was actually used. Petitioner claims that the dilution recommended by the Grebe-Sanford process substantially reduces the viscosity of the acid, greatly slows its reaction on limestone (thus allowing the acid to open up channels distant from the well hole instead of spending itself immediately and entirely

on the nearby rock) and greatly reduces its corrosive action on iron and steel.[4]

Nothing appears in the Grebe-Sanford patent claims, however, to support the thesis that dilution is part of the alleged invention. The main concern seems to have been directed at the failure of Frasch to recommend the use of an inhibiting agent. The suggested strength of the Grebe-Sanford solution is merely the one "in general best adapted to the purpose in hand" and it is said that "other concentrations may be used, if desired." Apparently dilution is recommended since the inhibiting agent can act more effectively with a weaker acid, which is obviously less corrosive than a more concentrated acid. At the same time, the recommended dilution allows the solution to be of a strength such that the soluble salts formed by its action on the rock will remain dissolved therein. The patent does not state that an acid outside the range of 5% to 20% strength will fail and no affirmative advantage over the Frasch method is claimed insofar as the strength of the acid is concerned.

But even assuming that a dilute solution is an ingredient of the alleged invention, we can find none of the elements of true invention adhering thereto. The mere addition of water to dilute a known chemical solution does not entitle one to a patent monopoly, at least unless a definite dilution point or range is discovered corresponding to a physical phenomenon. *Kwik Set, Inc.* v. *Welch Grape Juice Co.*, 86 F. 2d 945, 947. No such discovery was made here. The advantages said to accompany a dilute solution do not correspond to any particular dilution point or range. The patent recommends that the acid be diluted to a 5% to 20% strength but it is recognized that "other concentrations may be used, if desired," to achieve the purpose at hand. Such a broad and indefinite specification as to dilution is fatal to a claimed invention.

(3) *The use of the ordinary pump tube.* The Grebe-Sanford patent mentions the use of the ordinary pump tube to convey the acid to the bottom of the well hole, whereas the Frasch patent had contemplated withdrawal of the ordinary pump tube in favor of a smaller and specially protected supply tube. But this is at most an incidental and unimportant part of the Grebe-Sanford

[4] There was evidence introduced to the effect that a hydrochloric acid solution is much more corrosive when it contains 30% HCl than when it contains from 5% to 20%.

method, as is recognized by the statement in the patent that "it is not necessary, however, to add the acid solution through the pump tube, as any other convenient way may be employed." No new function is performed by the pump tube that is not performed by the Frasch supply tube; both merely convey the acid to the bottom of the well hole. Any advantage in cost or simplicity which the use of the ordinary pump tube may give is the result of the use of an inhibitor in the acid rather than any intrinsic merit of the pump tube. It is elemental that the mere substitution of equivalents which do substantially the same thing in the same way, even though better results may be produced, is not such an invention as will sustain a patent. *Dunbar* v. *Myers*, 94 U. S. 187, 199; *Smith* v. *Nichols*, 21 Wall. 112, 119.

Finally, petitioner claims that the Grebe-Sanford process has filled a long felt want and has been a commercial success. But these considerations are relevant only in a close case where all other proof leaves the question of invention in doubt. *Smith* v. *Hall*, 301 U. S. 216, 233; *McClain* v. *Ortmayer*, 141 U. S. 419, 428, 429. Here the lack of invention is beyond doubt and cannot be outweighed by such factors. Moreover, there is an absence in this case of any long felt want or of any recognized problem that had baffled the contemporary art. There is no evidence that any one with knowledge of the Frasch method and with knowledge of the use of inhibitors in hydrochloric acid ever tried unsuccessfully to use the Frasch method with inhibited hydrochloric acid. Nor is there any proof of fruitless demands and efforts to prevent corrosion while acidizing oil wells. Whenever the need arose to prevent corrosion in the use of hydrochloric acid, whether for purposes of pickling, scale removal or oil well acidizing, the addition of inhibitors was suggested immediately and without effort. The great fund of public knowledge was simply drawn upon the first time the problem was considered, resulting in the obvious process described in the Grebe-Sanford patent.

Since we conclude that the Grebe-Sanford patent is invalid for want of invention, we need not consider respondent's cross-petition raising questions as to whether respondent's process infringed the patent.

Affirmed.